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TAR SAND TRIANGLE

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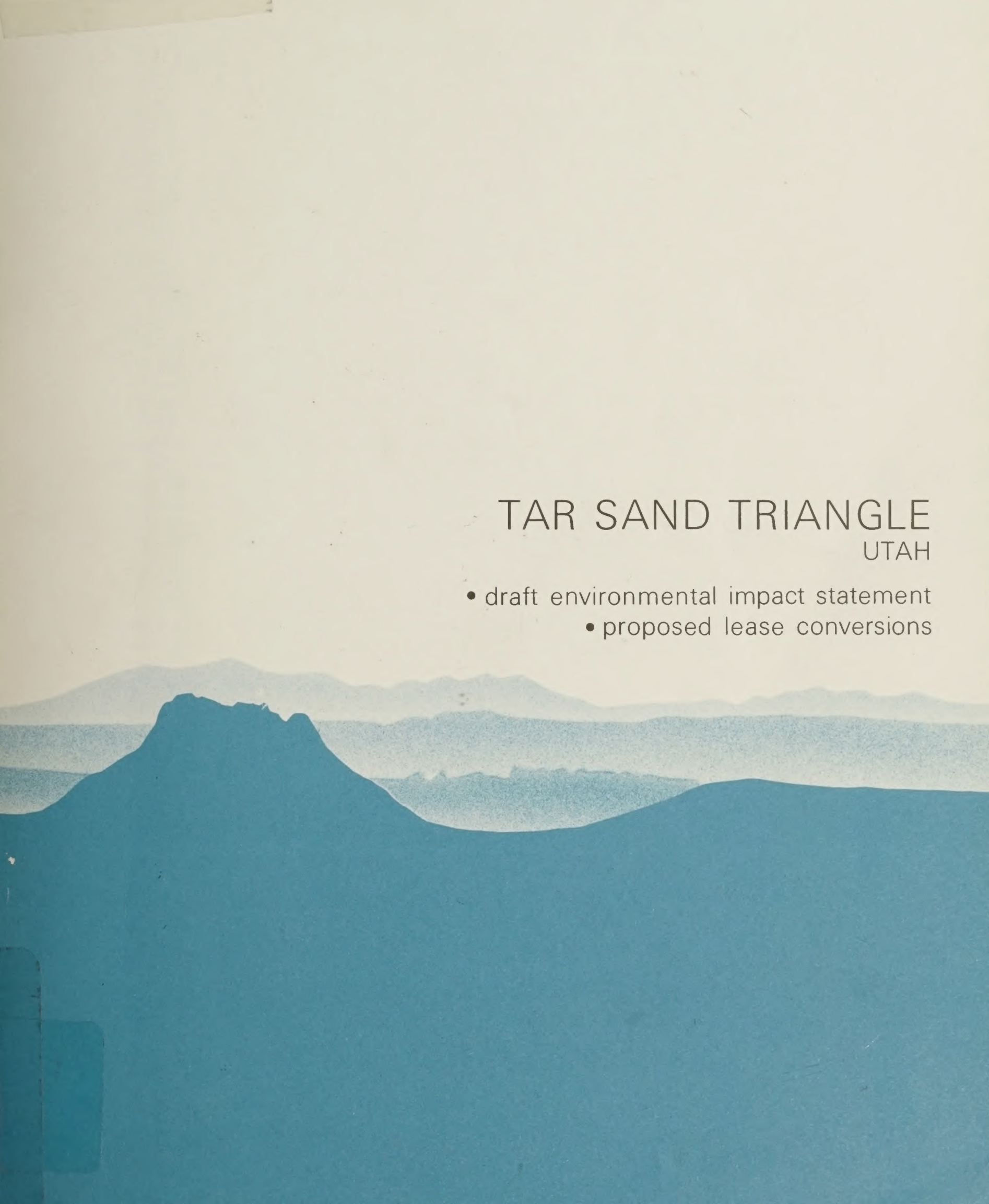
- proposed lease conversions



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UNITED STATES DEPARTMENT OF THE INTERIOR

NATIONAL PARK SERVICE AND BUREAU OF LAND MANAGEMENT

DRAFT ENVIRONMENTAL IMPACT STATEMENT

on

Conversion of Oil and Gas Leases
to
Combined Hydrocarbon Leases

Tar Sand Triangle
Utah

The Draft Environmental Impact Statement will provide the Regional Director, National Park Service, and State Director, Bureau of Land Management, with the necessary information to make a decision on whether existing oil and gas leases in Glen Canyon National Recreation Area and on adjacent BLM lands can be converted to combined hydrocarbon leases that would allow the development of the tar sand resource in accordance with section 8 of the Combined Hydrocarbon Leasing Act. Specifically, the Draft Environmental Impact Statement considers alternatives of converting all leases (the proposed action), as proposed by the applicants; converting a portion of the leases with additional protective restrictions, and not converting any of the applicants' leases (no action).

Comments may be submitted to Robert B. Kasparek, Regional Environmental Coordinator, Rocky Mountain Regional Office, National Park Service at the following address:

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SUMMARY

INTRODUCTION

A group of energy companies and individual lessees holding federal oil and gas leases in the Tar Sand Triangle Special Tar Sand Area (STSA) have applied to the Bureau of Land Management (BLM) to convert their leases to combined hydrocarbon leases (see Southeastern Utah map), as provided for by the Combined Hydrocarbon Leasing Act (CHLA) of 1981. Holders of preexisting oil and gas leases in STSAs have a limited opportunity to obtain the tar sand rights noncompetitively by applying to convert their leases to combined hydrocarbon leases. The conversion application requires filing (before November 16, 1983) a plan of operations that demonstrates diligent development of the tar sand resource and reasonable protection of the environment. The present application originated under the conversion provisions of the CHLA and was accepted by the BLM as of December 16, 1982.

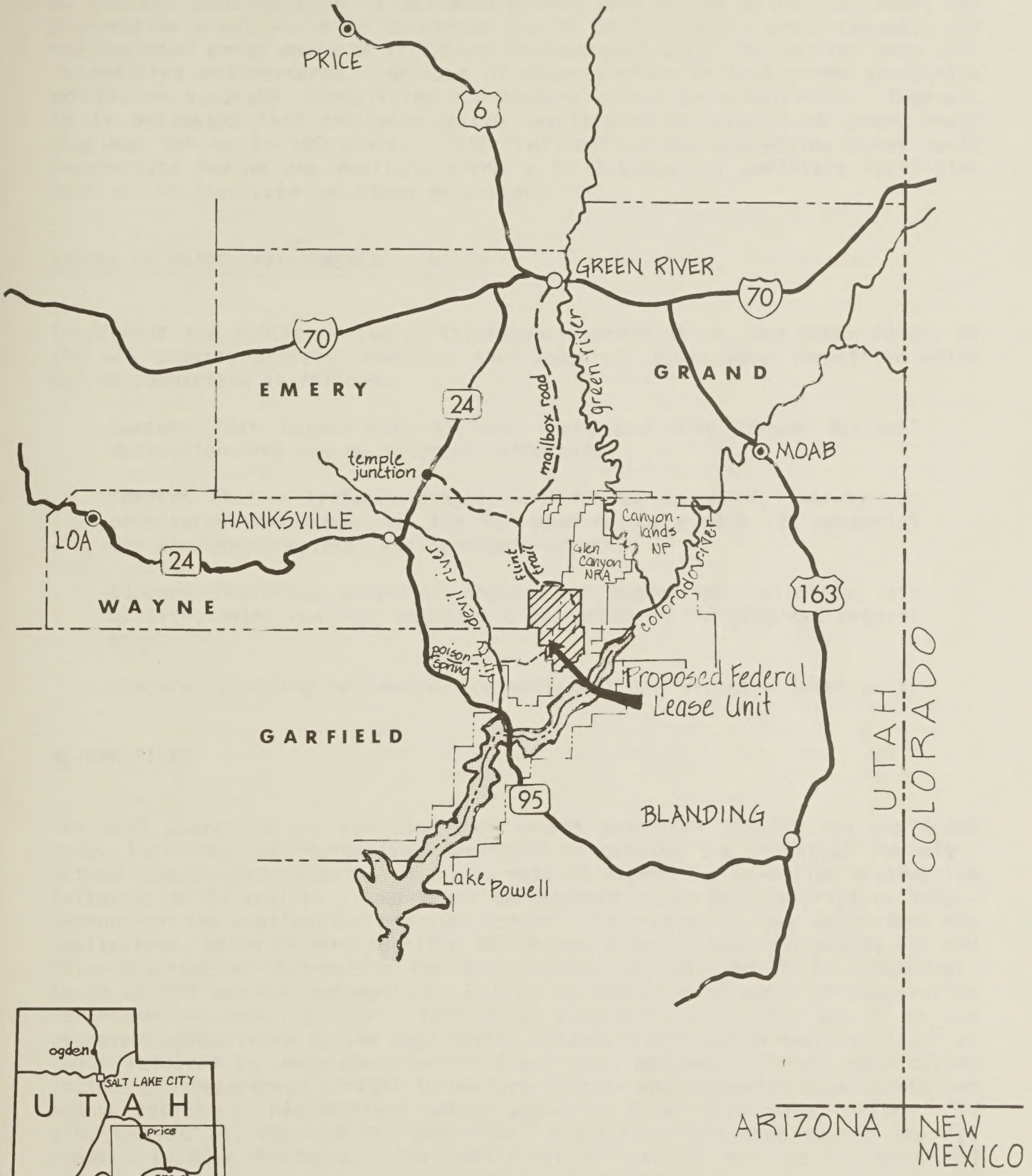
If leases are approved for conversion, the BLM will issue new combined hydrocarbon leases with a 10-year term to holders of existing oil and gas leases. These new combined hydrocarbon leases would give the holders the right to pursue development of the tar sand resource. Any leases converted would include the understanding that development activities would be controlled though lease restrictions and additional environmental reviews. Additional environmental reviews would be tiered from the Environmental Impact Statement (EIS). As development of the leases proceeds and details of the process are clearly defined, additional environmental analysis of project designs would be required and could result in project design and implementation adjustments in order for the lessees to conduct specified activities. However, lease conversion would represent the Department of the Interior's tentative finding that a commercial level of tar sand development may be allowed, providing lease restrictions are met. Therefore, this analysis addresses the effects of tar sand development on converted leases, as well as the decision to convert leases.

Approximately one-half of the applicant's proposed lease unit is within Glen Canyon National Recreation Area (NRA), a unit of the national park system managed by the National Park Service (NPS). Converting existing oil and gas leases within the NRA to combined hydrocarbon leases requires NPS consent. Consequently, the NPS is evaluating the applicant's proposal concurrently with the BLM, focusing on the environmental impacts of the proposed development. Under the laws and regulations governing lease conversions, the NPS may consent to lease conversion only upon a finding that the proposed lease conversions and subsequent development of the tar sand resource would have no resulting significant adverse impacts on the resources and administration of Glen Canyon NRA or on contiguous NPS units. Therefore, the NPS must evaluate the potential for adverse impacts on the contiguous Canyonlands National Park, as well as on Glen Canyon NRA.

The lease conversion application under consideration in this DEIS was submitted by Santa Fe Energy Company, Altex Oil Corporation, Benson-Montin-Greer Drilling Corporation, and 12 other holders of existing oil and gas leases. The application includes a proposal to combine the converted leases into a single 66,040-acre operating unit and to commercially develop the tar sand on the leases using an in-situ steam-drive extraction process. The plan of operations submitted by the applicants describes a four-phase program ranging from preliminary exploration through full-scale commercial development of the tar sand resource. Phases I and II, involving the drilling and testing of 2 and 15 coreholes respectively, are primarily exploratory activities designed to further define the characteristics and extent of the tar sand deposit within the proposed federal lease unit. Phase II could require up to 12 miles of new temporary access trails to the individual drill sites and a 200 x 200 foot cleared and leveled area for each drill pad. Drilling would be accomplished with trailer-mounted air drilling rigs.

Phase III would be a pilot-scale project for testing in-situ extraction processes and identifying optimal procedures for producing hydrocarbons from the deposit. This phase would require drilling of two adjacent five-spot well patterns, consisting of two central steam injection wells and eight production wells. The applicants are currently proposing a steam-drive process. The pilot plant would include a portable 10 to 15 million Btu/hr boiler for steam generation, a 125 KW diesel powered electrical generator, two water wells, and associated piping and pumping facilities. Leveling and clearing of approximately 15 acres would be required for the extraction zone and associated ancillary facilities. In addition, phase III could require widening, paving, or other improvements to the Flint Trail. The pilot phase would also include testing of upgrading methods on the extracted bitumen at an offsite laboratory.

Phase IV would be full commercial development, including eventual development of the entire leased acreage for extraction and ancillary facilities. At any given time during phase IV, activities would be concentrated in a single extraction zone (prospective area). Each extraction zone would be developed to produce bitumen at a rate of 30,000 barrels per day (bpd), with an active wellfield of approximately 1,000 production wells and 940 steam injection wells. To the extent possible given terrain constraints, each wellfield would be developed in 25-well modules, each drilled from a central wellpad served by a blacktopped road. A pump station on the Dirty Devil River and a 12- to 15-mile pipeline would be built to supply water needs, estimated at 1,679 acre-feet/year. The steam required for bitumen extraction and electrical power generation (up to 2.27 million pounds/hour) would be generated onsite in five fluidized bed combustion units. An onsite steam turbine (32 MW capacity) would generate electricity for facility needs. The bitumen would be processed in an onsite upgrading facility. This refinery-type facility would produce about 20,700 bpd of syncrude which would be transported to market via an as-yet undetermined method (pipeline or truck), and the remaining 9,300 bpd of production would be used as fuel for steam generation and other onsite needs. Numerous other onsite facilities would also be required including solid waste handling and disposal facilities for boiler waste (800 yd^3/day) and silt (170 yd^3/day), coking facilities, sulfur recovery plant, syncrude tankage, water storage reservoir (approximately 130 million gallons), water treatment plant, and reinjection wells for wastewater disposal. Access to these phase IV activities would be via the Flint Trail which would require major upgrading, including crowning, ditching, paving, and possibly bridging of major canyons.



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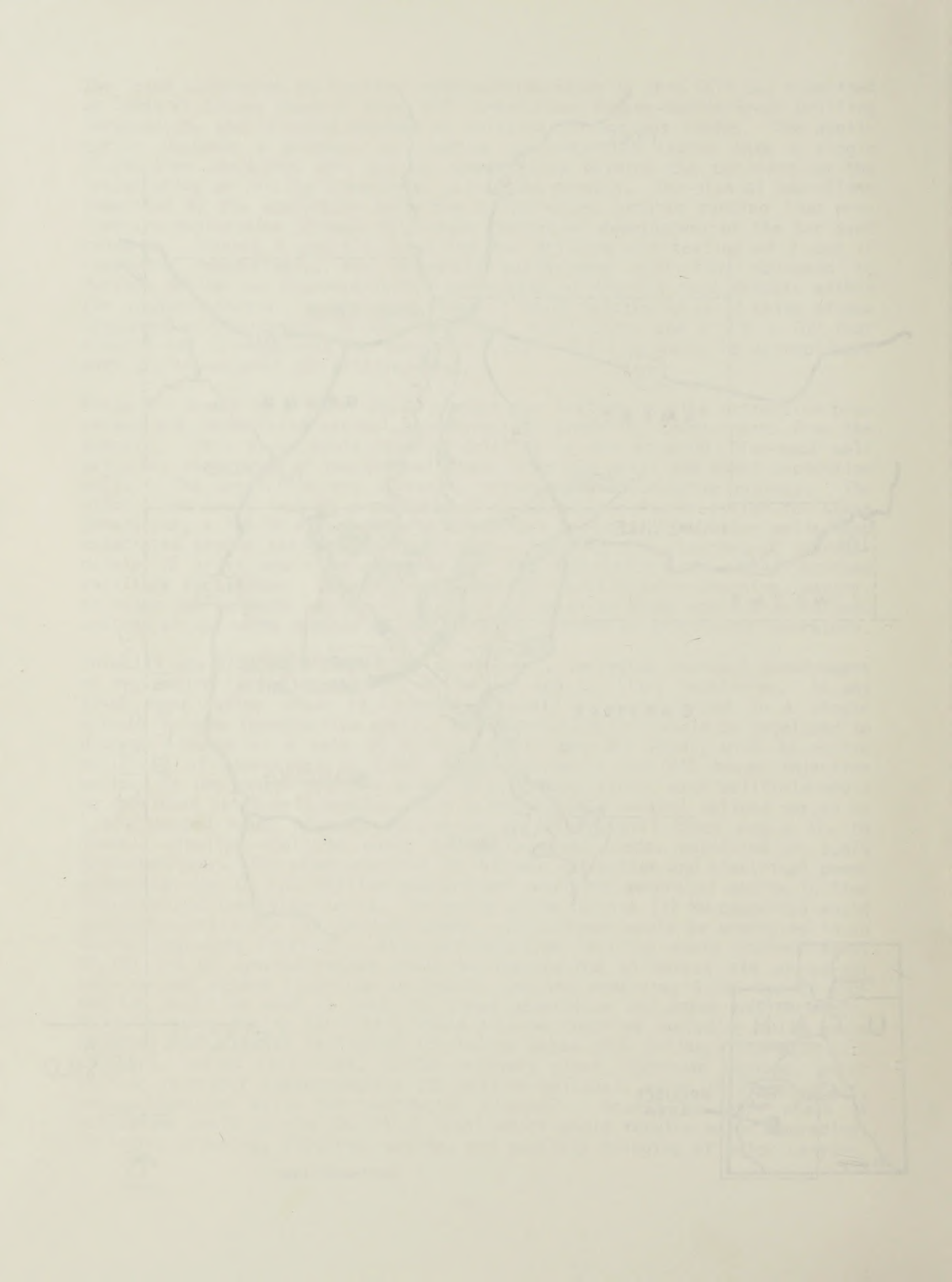

As the tar sand resource is depleted within each active extraction zone, new prospective areas would be developed (up to 18 such areas are proposed), and the depleted areas would be reclaimed sequentially until the entire lease unit is depleted and restored. Because of uncertainties regarding the production process an accurate schedule for the project cannot be established. However, it is estimated that the progressive development of extraction zones could continue for up to 160 years. This "rolling" of the extraction zones would necessitate moving and resiting (from 3 to 5 times) of ancillary facilities such as the fluidized bed steam generators.

ISSUES OF MAJOR ENVIRONMENTAL CONCERN

Throughout the public meetings, interagency coordination, and other facets of the EIS scoping process, numerous environmental issues were identified which can be summarized as follows:

Concern that Canyonlands National Park and Glen Canyon National Recreation Area may be adversely affected.

Concern that a synfuels project may not be approved; thereby not permitting development of the tar sand resource with its potential for attendant regional socioeconomic growth.

Concern regarding potential impacts on recreation, wildlife, air quality, water quality, and scenic resources in the proposed project area.

Concern regarding reclamation potential of the proposed lease unit.

ALTERNATIVES

The DEIS addresses two tar sand development scenarios (30,000 bpd and 5,000 bpd), including subalternatives developed to examine the potential for mitigating some project impacts. All alternatives except the no-action alternative (alternative 3) analyze a four-phase development scenario. Descriptive information for the applicants' proposed action (alternative 1) was taken from the application, which is more specific for phases I and II than for phases III and IV. Descriptive information for alternatives 2A, 2B, and 2C is conceptual, based on NPS and BLM assumptions, and is included for purposes of comparative environmental analysis. Descriptions of alternatives 2A, 2B, and 2C do not represent concurrence by the applicants. Standard mitigation measures (such as those required by regulatory authorities) are included. These restrictions include the Department's right to perform further environmental assessments and impose additional restrictions before approving later development phases. In alternatives 2A, 2B, and 2C, additional mitigation developed during the EIS process is also included. The additional mitigation restrictions suggested were developed using the best available information, and would be subject to adjustment once site-specific field studies are completed. The following alternatives are analyzed in this DEIS:

Alternative 1: Convert All Leases (Applicants' Proposal); this alternative is the action proposed by the applicant (converting all eligible federal leases) except that the leases located within portions of the NRA which are closed to mineral development are not eligible for conversion and would not be converted. The applicant proposed lease conversion for a 66,040-acre operating unit, but 11,494 acres are within a portion of the NRA closed to mineral disposition and thus are not eligible for conversion. Therefore, this alternative examines conversion and development on 54,546 acres.

Alternative 2A: Convert All Leases With Additional Protective Restrictions; this alternative proposes conversion of all eligible federal leases, as in alternative 1. However, protective restrictions developed to minimize impact on critical resources would be included in the leases. Specific restrictions are included to protect sensitive resources such as archeological sites, cliff edges, springs, raptor nests, highly erodible soils, access roads, viewsheds, and critical overlooks. With these restrictions, developable surface acreage would be reduced to 23,541 acres. A substantially lower production rate--5,000 bpd rather than 30,000 bpd--was also assumed to quantify differences in impacts related to the scale or intensity of development.

Alternative 2B: Deny Conversion on BLM Wilderness Study Area (WSA) Lands; this alternative is similar to alternative 2A except leases within WSAs would not be converted (other eligible federal leases would be converted with protective restrictions outlined in alternative 2A). The area available for surface development would be 14,090 acres under this alternative.

Alternative 2C: Deny Conversion on NPS National Recreational Area Lands; this alternative is similar to alternative 2A except that leases within the National Recreation Area would not be converted (other eligible federal leases would be converted with the protective restrictions outlined in alternative 2A). The area available for surface development would be 14,745 acres under this alternative.

Alternative 3: Deny Conversion of All Leases (No Action); this alternative would not allow conversion of existing oil and gas leases, thus preventing development of the tar sand resource by the current applicants. The applicants' existing leases would remain valid oil and gas leases until expiration of the lease term. The area would be available for future competitive leasing and development.

MAJOR IMPACT CONCLUSIONS

The analysis of impacts related to each alternative addresses the issues outlined previously, as well as other topics of legal responsibility or management concern to the NPS and the BLM. In general terms, the level of impacts and implications of the alternatives are summarized as follows:

Alternative 1: Convert All Eligible Federal Leases (Applicant's Proposal)

This alternative would result in significant unavoidable short and long term adverse impacts on geologic, topographic, and water resources, soils, vegetation, wildlife, air quality, noise levels, scenic quality, cultural resources, the socioeconomic environment, land use, and recreation and wilderness values.

The geologic subsurface formations would be extensively fractured, which could alter the chemical and physical rock characteristics and result in subsidence and rockfalls. Topographic features would be altered on up to 54,546 acres over the 160-year life of the project at the commercial development stage. Water resources could be adversely affected by steam injection and surface operations that disrupt aquifers and recharge areas; both quantity and quality of surface and groundwater could be reduced.

Soils would be disturbed on approximately 30,000 acres and cryptogamic soil crusts would be destroyed, resulting in significant increases in erosion. Up to 14,335 acres would be totally cleared of vegetation, and revegetation would be slow (up to 70 years to restore mature stands of pinyon-juniper) and difficult. Wildlife habitat would be adversely affected over the entire project area by human activity such as increased noise, traffic, and other disturbances. Habitat disturbance would adversely affect wildlife, particularly raptors and bighorn sheep. Reintroduction of bighorn sheep would be halted.

Preliminary modeling indicates that the project as proposed would violate national ambient air quality standards (NAAQS) for sulfur dioxide, which would result in adverse impacts on human health and on plant and animal communities. The class II Prevention of Significant Deterioration (PSD) increments for sulfur dioxide and particulates would be exceeded in the project area; thus, meaning the project as currently planned could not receive air quality permits. The class I PSD increments in Canyonlands and Arches National Parks would be exceeded. Adverse impacts on visibility could also result from the project as proposed.

Noise levels from the project (66 dbA 1,000 feet from the project area) would be significantly above maximum background levels and could result in adverse nonauditory effects on human and animal populations (such as stress, annoyance, and sleep loss) for a radius over 5 miles around the development area, for a period of 24 hours a day for the 160-year life of the project at the commercial development stage.

Existing high-quality scenic values within the operating area would be lost and the value of the Orange Cliffs as a scenic buffer for Canyonlands NP would be significantly diminished. Significant adverse effects on archeological resources would occur at sites throughout the unit due to surface disturbance, unauthorized collection and a loss of in-context data.

The large influx of people (2400 workers plus dependents in the peak year) would cause major shortages in housing, law enforcement, fire protection, health care and public utilities resulting in adverse socioeconomic impacts on local communities. These effects would recur up to 18 times over the life of the project as each new extraction zone is brought on line. The increase in numbers of people would benefit local communities economically that furnish goods and services to newcomers.

The recreational experience in Glen Canyon NRA and in the adjoining Maze district of Canyonlands NP will be shifted from a primitive experience to that of a developed area as visitation increases tenfold due to the upgrading of access routes. This will result in a degradation of the recreational experience for those seeking a primitive and unconfined experience and would be in direct conflict with the NPS management objectives for the area. In addition, wilderness values would be adversely affected in the project area by noise, odor and visual intrusion, as well as the physical impact of the development itself. In the WSAs direct activities would have to be precluded in order to maintain the nonimpairment standard.

Alternative 2A: Convert All Leases with Additional Protective Restrictions

This alternative analyzes a lower production rate (5,000 bpd) with application of additional protective restrictions. Project location and design adjustments would be required, and the tar sand resource would not be fully recoverable. Application of protective measures would reduce the impacts of the project; however, certain unavoidable adverse impacts would remain.

Impacts on geologic resources (such as the likelihood of rockfalls due to subsidence and steam fracturing of cliff faces) would be reduced under this alternative because of cliff setback requirements. Topographic disturbance would be unavoidable and would occur on up to 23,541 acres resulting in major alterations of the existing landscape character and form. Impacts on springs, seeps, and wells would be reduced by the one-half mile setback from water sources. However, development could dewater springs and seeps in the vicinity of the lease unit; any diminution of flows or water quality in this arid region would have significant adverse effects on humans and animals in the area.

Impacts on soils would be reduced by applying mitigative restrictions that preclude ground-disturbing activities in high-hazard soil areas or on steep slopes. Approximately 13,100 acres of soils would be disturbed during the life of the project with significant resulting soil loss and erosion potential. Vegetation would be removed totally from approximately 5,902 acres over the 160-year life of the project. Reclamation would be difficult and could take up to 70 years after operations cease (to restore mature stands of pinyon-juniper); this would adversely affect the best example of this woodland type within the recreation area. Up to 23,541 acres of wildlife habitat could be disturbed for a period exceeding 160 years (up to 265 acres would be directly disturbed at any one time). An additional amount of habitat would be altered by indirect effects such as noise, traffic, human intrusion, and exclusion from water sources. Reintroduction of desert bighorn sheep would be halted and adverse impacts would occur on the existing population. Similar significant and unavoidable impacts (both direct and secondary) are expected to occur on other large species and raptors.

Air quality effects include exceedance of the PSD class II sulfur dioxide increment in Glen Canyon NRA, which could prevent permitting of the facility. The PSD class I sulfur dioxide increment would also be exceeded in Canyonlands NP. In addition, significant adverse impacts on visibility are possible, depending upon the exact location and configuration of the upgrading plant.

Noise levels significantly above maximum background levels (58 dbA at 1,000 feet during the operational stage of phase IV) would occur within a 2-3 mile radius of the site and could result in adverse nonauditory effects such as increased stress, sleep loss, and annoyance. Scenic resource impacts on Canyonlands NP would be reduced by the application of scenic setbacks, but degradation of scenic quality would still occur within the NRA and on the park. Visual resource management (VRM) standards would be exceeded on 8,946 acres of BLM lands within the proposed federal lease unit.

Direct impacts on the most significant archeological resources are not expected due to the application of protective restrictions, but large amounts of in-context materials would be destroyed or irrevocably altered. Significant secondary impacts on cultural resources could occur due to damage and vandalism from increased visitation.

Local communities would experience an influx of people (390 workers plus dependents in the peak year) resulting in shortages in housing, public utilities, education and fire protection. These effects would recur up to 18 times as each prospective area is brought on line. Impacts on wilderness and recreation are expected to be similar to those described under alternative 1.

Alternative 2B: Deny Conversion on BLM Wilderness Study Area (WSA) Lands and Convert All Other Eligible Federal Leases with Protective Restrictions

This alternative is similar to alternative 2A in that it analyzes a lower production rate with application of additional protective restrictions. In addition, no lease conversions (and thus no development activity) would be permitted in BLM WSAs, so direct impacts on WSA lands would be eliminated. The adverse effects of the project on geology, water resources, wildlife, air quality, cultural resources, wilderness and recreation would be similar to alternative 2A except that direct effects would not occur in the WSAs. Impacts may also be of shorter duration since the developable acreage would be less.

Topographic disturbance and alteration of existing landscape forms would occur on 14,090 acres. Impacts on soils would be reduced by applying mitigative measures discussed in alternative 2A; approximately 7,447 acres would be disturbed over the life of the project with the attendant potential for soil loss and erosion. Approximately 3,582 acres of vegetation would be removed over the life of the project and would be difficult to reclaim. Noise impacts would be similar to alternative 2A, but areas within WSAs would have the benefit of additional attenuation distance so that adverse nonauditory effects (such as sleep loss and annoyance) would be reduced. Impacts on scenic resources are similar to those described in alternative 2A, except that not converting leases in the WSAs would make construction of major upgrading facilities in Glen Canyon NRA more likely, resulting in an increase in scenic resource conflicts in both Glen Canyon NRA and Canyonlands NP.

Impacts on local communities are similar to those described for alternative 2A. Effects could recur up to 13 times as each new prospective area is brought on line.

Alternative 2C: Deny Conversion on NPS National Recreation Area Lands and Convert All Other Eligible Federal Leases with Protective Restrictions

This alternative is also similar to alternative 2A in that it analyzes a lower production levels and the application of protective restrictions. In addition, no lease conversions (and thus no tar sand development activity) would be permitted in the National Recreation Area. Certain project location and design adjustments would be required to avoid the National Recreation Area and meet the nonimpairment standard for WSAs.

Impacts on geology, water resources, wildlife, air quality, cultural resources, wilderness and recreation would be similar to those described for alternative 2B except that National Recreation Area lands would not be directly disturbed for operational activities.

Topographic disturbance and alteration of landscape forms would occur on up to 14,457 acres. Impacts on soils would be reduced by applying mitigative measures discussed in alternative 2A; approximately 7,523 acres would be disturbed over the life of the project, with consequent potential for erosion and soil loss. Approximately 3,435 acres of vegetation would be removed over the life of the project. Noise impacts would be similar to alternative 2A, but areas within Canyonlands NP and eastern portions of Glen Canyon NRA would have the benefit of additional attenuation distance so that adverse nonauditory effects such as sleep loss and annoyance would be reduced within the NRA and Canyonlands NP. Impacts on scenic resources would be similar to those described in alternative 2A, except that not converting leases within Glen Canyon NRA would minimize scenic resource conflicts in Glen Canyon NRA and Canyonlands NP. BLM's visual resource management (VRM) standards are expected to be exceeded on 8,946 acres of BLM land within the proposed federal lease unit.

Impacts on local communities are similar to those described for alternative 2A. Effects could recur up to 8 times as each new prospective area is brought on line.

Alternative 3: Deny Conversion of all Leases (No Action)

This alternative would result in no change in the natural environment and no adverse impacts on Canyonlands National Park and Glen Canyon NRA due to tar sand development. There would be no development of tar sand resource by the applicants, but existing oil and gas leases would remain valid until the expiration of the original term, and could be developed for oil and gas. The tar sand resource would be available for competitive leasing in the future. There would be no regional economic gains from the proposed project and no economic gain to holders of the existing oil and gas leases from tar sand development.

The major environmental consequences of the alternatives are summarized and compared in the following table.

Comparison of Environmental Consequences of the Alternatives
(Development Phases I-IV)

	Alternative 1 Convert All Leases (Applicants' Proposal)	Alternative 2A Convert All Leases With Protective Restrictions	Alternative 2B Deny Conversion in WSAs	Alternative 2C Deny Conversion in NRA	Alternative 3 Deny Conversion of All Leases (No Action)
Geology	The extensive subsurface fracturing required (areal extent 38,790 acres) could change the chemical and physical rock characteristics and result in subsidence and rockfalls	Likelihood of rockfalls would be reduced by cliff setback requirement	Likelihood of rockfalls reduced by cliff setback requirement	Likelihood of rockfalls reduced by cliff setback requirement	Sporadic oil and gas activity would continue; subsidence and rockfalls would be unlikely
Topography	Construction activities (including road building, pipelines, steam generation and upgrading facilities) would alter topographic features on up to 54,546 acres within the extraction areas in increments of about 1,400 acres at any one time	Disturbance would occur on 23,541 acres in increments of about 265 acres at any one time	Disturbance would occur on 14,090 acres in increments of about 265 acres at any one time	Disturbance would occur on 14,457 acres in increments of about 265 acres at any one time	Continued oil and gas exploration and development would not require construction of analogous major industrial facilities; topographic disturbance would therefore be minimal
Paleontology	Direct effects are not expected to be significant; secondary effects (increased collection and vandalism) could occur due to increased numbers of people in the area	Direct effects not significant; secondary effects due to numbers of employees about one-sixth that of alternative 1; secondary effects due to increased visitation similar to alternative 1	Similar to alternative 2A	Similar to alternative 2A	Direct effects are not expected to be significant; secondary impacts would continue at historic levels
Energy and Minerals	30,000 bpd bitumen would be removed over an indefinite time period, reducing the amount of reserves available; recovery of uranium resources from the same areas would be reduced or precluded	5,000 bpd bitumen would be removed over an indefinite time period, reducing the amount of remaining reserves available; recovery of uranium resources from the same areas would be reduced or precluded	Similar to alternative 2A	Similar to alternative 2A	The bitumen resource would remain in place and available for future competitive leasing; conflicts between oil and gas activity and uranium resource recovery would be minimal

	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Water Resources	Annual processing and extraction water use would be 1,679 acre-feet (from the Dirty Devil River), 2.0 to 2.7 tons of silt per acre-foot would be disposed of onsite; steam injection and surface operations could disrupt aquifers and recharge areas and may reduce quantity and quality of flows in springs, seeps, and wells; availability of groundwater for future uses could be reduced	Annual processing and water use would be 280 acre-feet (from the Dirty Devil River); 2.0 to 2.7 tons of silt per acre-foot would be disposed of onsite; impacts on springs, seeps, and wells would be reduced by one-half-mile setback from water sources	Similar to alternative 2A	Similar to alternative 2A	Water use requirements would be minimal for oil and gas activity; because high pressure steam injection would not be done, major aquifer disruption is not anticipated
Soils	Approximately 29,882 acres would be disturbed during the life of the project; 50 million cubic yards of soils would be moved; cryptogamic soil crusts would be destroyed	Approximately 13,100 acres of soils would be disturbed during the life of the project; 21 million cubic yards of soils would be moved; slopes in excess of 33 percent and high erosion hazard soils would be avoided	Approximately 7,447 acres of soils would be disturbed during the life of the project; 12 million cubic yards of soils would be moved; slopes in excess of 33 percent and high erosion hazard soils would be avoided	Approximately 7,523 acres of soils would be disturbed during the life of the project; 12 million cubic yards of soils would be moved; slopes in excess of 33 percent and high erosion hazard soils would be avoided	No significant impacts anticipated
Vegetation	Approximately 14,335 acres of vegetation would be cleared over the life of the project; reclamation would be slow and difficult due to arid environment and intensive measures would be required; no threatened or endangered species would be affected	Approximately 5,902 acres of vegetation would be lost over the life of the project; reclamation would require intensive measures to be successful; no known threatened or endangered species would be affected	Approximately 3,582 acres would be removed over the life of the project; however, no more than 265 acres would be disturbed at any one time; reclamation would require intensive measures to be successful; no known threattened or endangered plant species would be affected	Approximately 3,435 acres would be totally removed over the life of the project; however, no more than 265 acres would be disturbed at any one time; reclamation would require intensive measures to be successful; no known threattened or endangered species would be affected	No significant impacts anticipated

	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Wildlife	Up to 54,546 acres of wildlife habitat would be disturbed over a 160 year period; up to 1,400 acres would be actively disturbed at any one time; adverse impacts on all wildlife from increased human activity, noise, and other disturbance; reintroduction of bighorn sheep into the area may be slowed or halted; raptor habitats would be disturbed or project operation modified for up to four months per year	Up to 23,541 acres of wildlife habitat could be disturbed over a period exceeding 160 years; up to 265 acres would be disturbed at one time; bighorn reintroduction may be slowed or halted	Similar to alternative 2A except that the intensity of the impacts would be reduced in the WSAs	Similar to alternative 2A, except that the intensity of the impacts would be reduced in the NRA and Canyonlands	Impacts significantly above existing levels not anticipated
Air Quality	For 4% sulfur bitumen, the 3-hour class II SO_2 PSD increment would be exceeded by a factor of 1.54, the 24-hour increment by a factor of 5.83, and the NAAQS for SO_2 would be exceeded by 1.49; short-term class II particulates PSD increment would be exceeded by a factor of 8.28, the annual by 7.42, the 24-hour NAAQS for particulates would be exceeded by 1.52, and the annual by 2.12; maximum concentration levels would occur in Glen Canyon; for 4% sulfur bitumen, short-term and annual class I SO_2 PSD increments would be exceeded in Canyonlands and the 24-hour SO_2 increment would be exceeded in Arches NP; adverse effects on visibility expected in Canyonlands	For 4% sulfur bitumen, the short-term class II SO_2 PSD increment would be exceeded by a factor of 1.38 in Glen Canyon; the short-term class I SO_2 PSD increment would be exceeded by a factor of 1.3 in Canyonlands; adverse impacts on visibility would be moderate, but depending upon the exact location and configuration of the upgrading plant, could still be of concern; adjustments in plant design could enable this alternative to meet air quality standards at a production level in the range of 2,800-5,000 bpd	Similar to alternative 2A	Similar to alternative 2A	Changes in existing air quality are not expected

	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Noise	Noise levels at the Gordon Flats site would be high enough to cause hearing impairment within 600 feet of edge of site; adverse nonauditory effects (stress, annoyance, sleep loss, etc) would occur at and adjoining to development areas 24 hours per day for the 160 year life of the commercial development phase	Noise levels high enough to cause adverse auditory effects offsite are not anticipated; noise levels significantly above maximum background levels would occur within a 2-mile radius of site; adverse nonauditory effects would be reduced	Similar to alternative 2A, but areas within WSAs would have the benefit of additional attenuation distance, so adverse nonauditory effects would be reduced	Similar to alternative 2A, but areas within Canyonlands and eastern portions of Glen Canyon would have the benefit of additional attenuation distance so adverse nonauditory effects would be reduced	Noise levels significantly above existing levels not anticipated
Scenic Quality	Existing high-quality scenic values within the operating area would be lost; value of the Orange Cliffs as a scenic buffer to Canyonlands would be seriously diminished; much of the operation would be visible from Canyonlands; BLM's VRM management class restrictions would be exceeded for 19,000 acres of the project area	Scenic setbacks applied; scenic resource impacts in Canyonlands minimized; overall impact on the rest of the area reduced (but not eliminated) by applying mitigation measures; VRM standards would still be exceeded on 8,946 acres of BLM land; scenic qualities adversely affected in Glen Canyon	Similar to alternative 2A, except if WSAs are not converted, construction of major upgrading facilities in Glen Canyon is more likely, resulting in an increase in scenic resource conflicts in Glen Canyon and Canyonlands; VRM standards exceeded on 2,891 acres of BLM land; scenic qualities adversely affected in Glen Canyon	Similar to alternative 2A, except that nonconversion within Glen Canyon would minimize (but not eliminate) scenic resource conflicts in Glen Canyon and Canyonlands; VRM standards exceeded on 8,946 acres	Impacts above existing levels not anticipated
Cultural Resources	Major adverse effects on archeological sites throughout the unit through surface disturbance, unauthorized collecting and loss of in-context data; a minimum of 2,000 archeological sites in the unit could be affected; secondary impacts on the archeological resources of Canyonlands, including Horseshoe Canyon, from the increased numbers of people in the area	Limitations on surface disturbance would reduce direct impacts; a minimum of 885 sites could be disturbed; secondary effects due to numbers of employees about one-sixth that of alternative 1; secondary effects due to increased visitation similar to alternative 1	Similar to alternative 2A; direct impacts on archeological resources in the WSA would be prevented; a minimum of 530 sites could be disturbed	Similar to alternative 2A; direct impacts on archeological resources in the NRA would be minimal; a minimum of 545 sites could be disturbed	Impacts above existing levels not anticipated

	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Socio-economics	Local communities would experience a large influx of workers (2,400 workers in 1994); major shortages would occur in housing, education, law enforcement, fire protection, health care, and public utility sectors; effects could recur up to 18 times as each new prospective area is brought on line; travel on several highways and roads in the area would exceed capacity resulting in road deterioration and higher operating costs; annual income for local communities and residents associated with the project would increase; localized inflation may occur	Local communities would experience an influx of workers with a peak year workforce of 390 in 1994; shortages would occur in housing, public utilities, education, and fire protection; travel on a portion of UT 24 would exceed capacity; effects could recur up to 18 times as each new prospective area is brought on line; annual income for communities and residents associated with the project would increase; localized inflation may occur	Local communities would experience an influx of workers with a peak workforce of 390 in 1994; shortages would occur in housing, public utilities, education, and fire protection; travel on a portion of UT 24 would exceed capacity; effects would recur up to 13 times as each new prospective area is brought on line; annual income for local communities and residents associated with the project would increase; localized inflamay occur	Local communities would experience an influx of workers with a peak workforce of 390 in 1994; shortages would occur in housing, public utilities, education, and fire protection; travel on a portion of UT 24 would exceed capacity; effects would recur up to 8 times as each new prospective area is brought on line; personal annual income for residents associated with the project would increase; localized inflation may occur	Impacts above existing levels not anticipated
Recreation	Approximately 3,500 visitors per year seeking primitive and unconfined recreation would experience a degradation of the recreational experience in 23,336 acres of Glen Canyon and in adjacent portions of Canyonlands; visitation to Hans Flat could increase by about 950% due to access upgrading, shifting the recreational experience from primitive to developed, in conflict with NPS objectives of maintaining the primitive and unconfined recreational experiences in Glen Canyon and preservation of resources in Canyonlands	Similar to alternative 1, but direct land disturbance would be reduced to 23,541 acres; conflicts with recreation use in Glen Canyon and Canyonlands would be reduced somewhat	Similar to alternative 2A, but direct disturbance of WSA lands would be eliminated; 14,090 acres of Glen Canyon and other BLM lands would be disturbed; conflicts with recreation use of BLM land would be reduced	Similar to alternative 2A, but NRA lands would not be disturbed for operational activities; 14,745 acres would occur all on BLM lands; conflicts with recreational use in Glen Canyon and Canyonlands would be reduced	Minor impacts (consistent with existing levels) on recreation could occur, but could be minimized by careful siting of oil and gas operations and restrictions on use of access routes

	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Wilderness	Portions of 455,330 acres of potential wilderness (9 areas) could be adversely affected by noise, sight, and odor intrusions, particularly in portions of four potential WSAs adjacent to project components; direct disturbance of 15 acres, in three BLM WSAs considered nonimpairing to wilderness values would be allowed under phases I and II; phases III and IV activities probably precluded in WSAs by nonimpairment standard; if WSAs are released by Congress, phases III and IV could proceed without impairment to the National Wilderness Preservation System, and if WSAs become designated wilderness, phases III and IV would not be allowed	Similar to alternative 1	Similar to alternative 1, but no direct disturbance would occur in WSAs	Similar to alternative 1	Impacts above existing levels not anticipated

AGENCY PREFERRED ALTERNATIVE

This DEIS involves combined hydrocarbon lease conversions in the Tar Sand Triangle, Utah, and includes lands under the jurisdiction of the NPS (within Glen Canyon National Recreation Area) and the BLM. The requirement of identifying a preferred alternative in this DEIS has been waived (per memorandum of the Department of the Interior, Office of Environmental Project Review, dated October 12, 1983). The bureaus will identify their preferred alternative in the final EIS.

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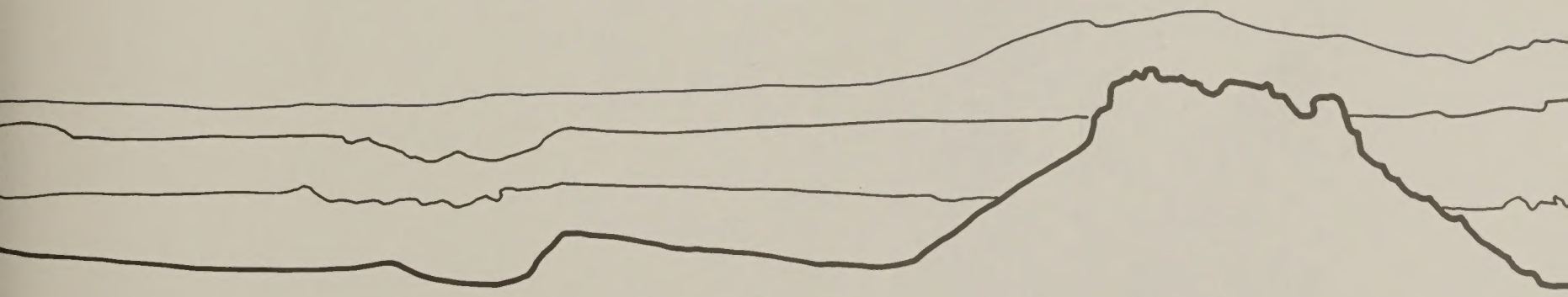
PURPOSE OF AND NEED FOR ACTION



INTRODUCTION

A group of energy companies and individual lessees with federal oil and gas leases in the Tar Sand Triangle Special Tar Sand Area of southeastern Utah (see figure 1) have applied to the Bureau of Land Management (BLM) to convert their leases to combined hydrocarbon leases, as provided by the Combined Hydrocarbon Leasing Act (CHLA) of 1981. The application was accepted as of December 16, 1982. The CHLA requires federal agencies to take action on conversion applications within 15 months. Since a portion of the applicants' proposed federal lease unit lies within Glen Canyon National Recreation Area, a unit of the national park system managed by the National Park Service (NPS), both agencies (the BLM and the NPS) must take action by March 1984.

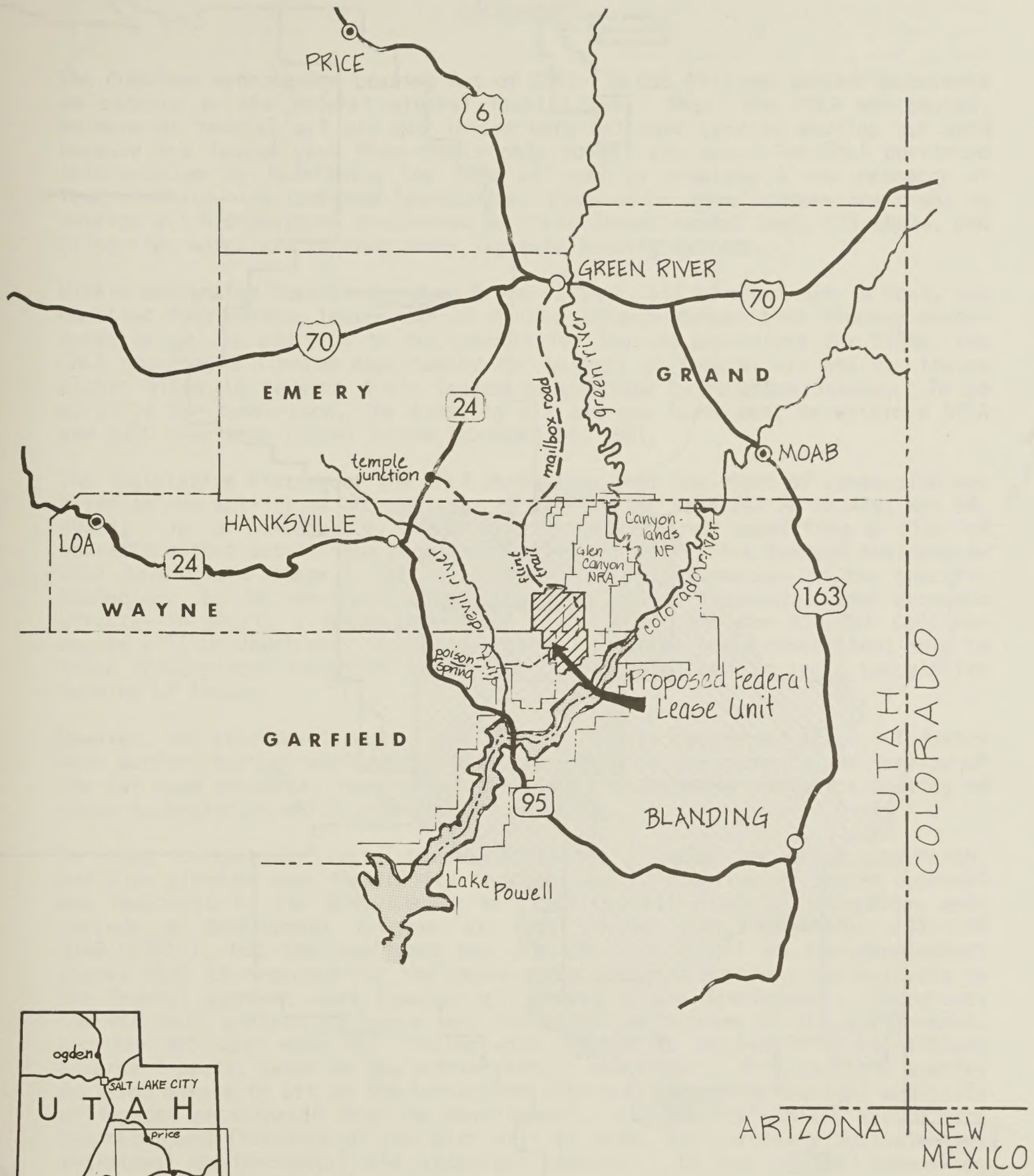
The regulations implementing the CHLA (43 CFR 3140) permit applicants to operate under unit operating agreements (43 CFR 3140.1-4; 30 CFR 226). In such cases, the plan of operations addresses the proposed development of the block of leases that constitute the unit rather than the development of each individual lease. This application includes a proposal to unitize the converted leases with state-leased and currently unleased lands into a single 66,040-acre operating unit and to commercially develop the tar sand on the leases. The development proposal is detailed in a plan of operations describing how the bitumen would be extracted from the White Rim sandstone beneath the leases using in-situ steam injection techniques, upgrading the bitumen to a transportable syncrude, and transporting it offsite (see appendix A for a detailed description of the applicants' plan of operations).

Because some of the lands included within the applicants' proposal are within portions of Glen Canyon National Recreation Area where new mineral disposition activities are prohibited by the approved Minerals Management Plan (USDI, NPS 1980), 11,494 acres of the unit originally proposed are not eligible for conversion. As the Secretary of the Interior has no discretion to convert leases or allow new mineral development in this 11,494-acre portion of the proposed federal lease unit, this acreage has not been analyzed. The area evaluated in this analysis (54,546 acres) is shown on figure 2. Because the applicants propose to develop this 54,546-acre area as a single operating unit, the analysis in this document assumes a unitized proposal.

Before leases can be converted, the BLM must find that the plan of operations submitted by the applicants demonstrates diligent development of the tar sand resource and reasonable protection of the environment (43 CFR 3140). In addition, for leases within Glen Canyon National Recreation Area, the oil and gas leases may be converted if the above conditions are met and if the NPS Regional Director finds that there will be no resulting significant adverse impacts on the resources or administration of that unit or any contiguous units of the national park system (43 CFR 3140.7). If leases are converted, new combined hydrocarbon leases with a primary term of 10 years are issued that would allow development of all hydrocarbons (including tar sand as well as oil and gas) except oil shale, coal, and gilsonite.

The NPS and the BLM agreed to jointly prepare an environmental impact statement (EIS) to aid the agencies in making the determinations required of each agency. The joint NPS-BLM Draft EIS (DEIS) explicitly recognizes the interrelationship

of the agencies' responsibilities and analyzes the consequences of the applicants' proposal and specific alternative federal actions as required by the National Environmental Policy Act (NEPA) of 1969 (42 USC 4332) and regulations (40 CFR 1500).



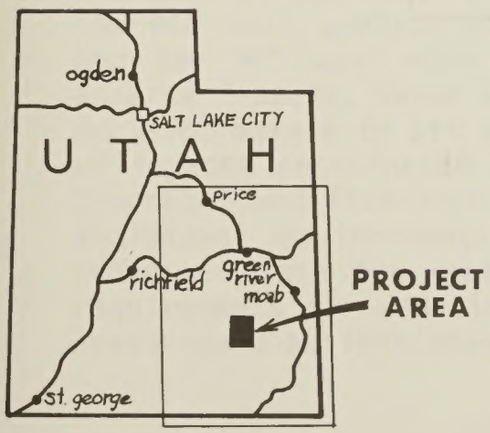


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Fig. 1. Southeastern Utah

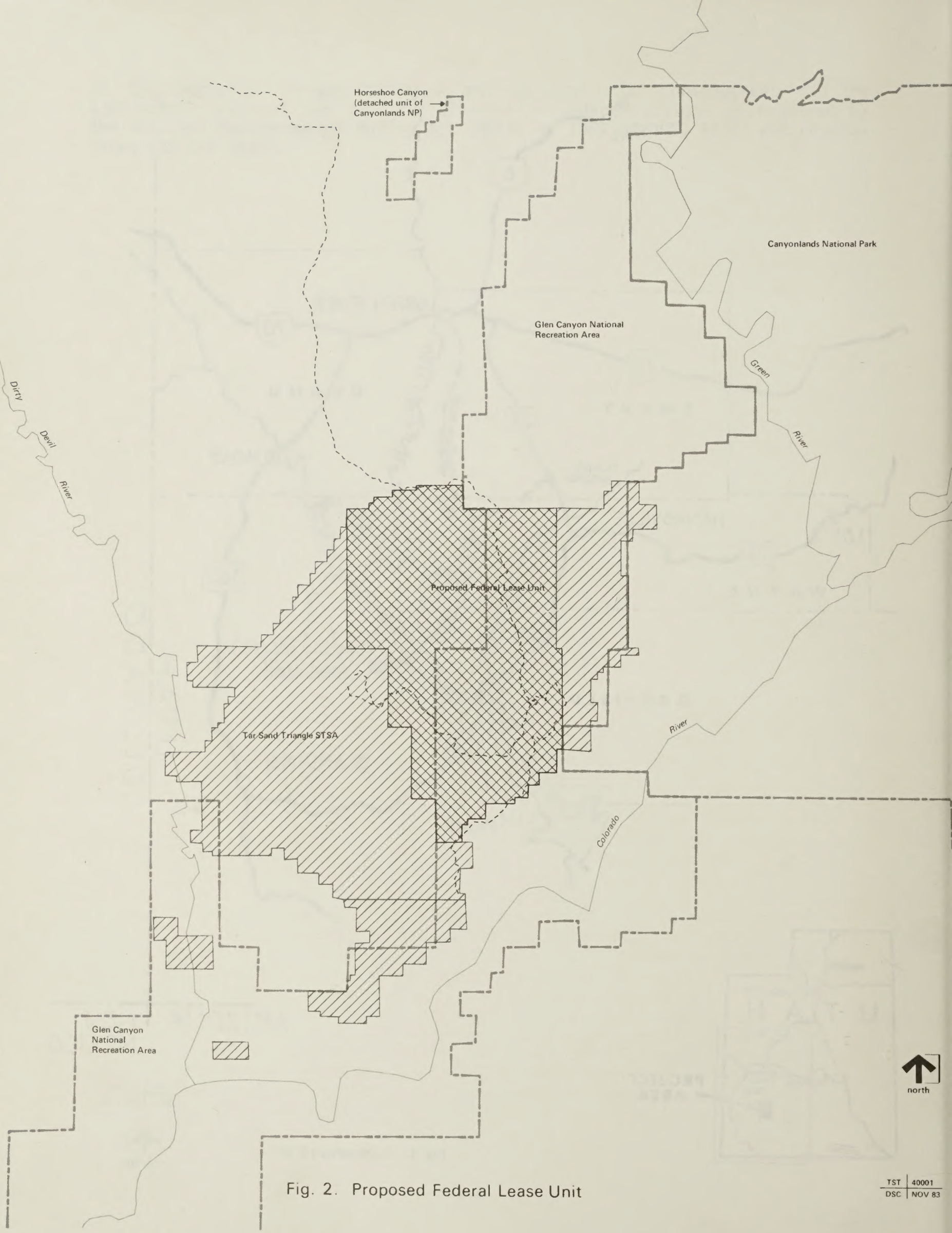

Fig. 2. Proposed Federal Lease Unit

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BACKGROUND

The Combined Hydrocarbon Leasing Act of 1981 (30 USC 181) was passed to correct an anomaly in the federal mineral leasing law. Until the CHLA was passed, holders of federal oil and gas leases were not permitted to develop tar sand because the leases gave them rights only to oil and gas. The CHLA corrected this problem by redefining the term oil and by creating a new category of federal lease--the combined hydrocarbon lease--which gave lessees the right to develop all hydrocarbons discovered on their leases except coal, oil shale, and gilsonite, which are covered under separate leasing systems.

Within designated Special Tar Sand Areas (STSAs), all of which are in Utah, new combined hydrocarbon leases can be issued through competitive bidding procedures only. In addition to the competitive leasing provisions for STSAs, the CHLA provided a limited opportunity for holders of federal oil and gas leases within STSAs to convert their leases to combined hydrocarbon leases. To be eligible for conversion, the existing oil and gas lease must be within a STSA and must have been issued before November 16, 1981.

The legislative history of the CHLA emphasizes that the right of conversion was based on the ability of an applicant to produce tar sand (47 FR 22,476; May 24, 1982). As a consequence, lease conversion requires submitting a plan of operations that details the proposed development activities through the commercial development stage. This plan must provide information on the specific technology to be employed and projections of environmental and economic effects--in short, a demonstration of where, when, and how the tar sand resource will be developed. Congress intended to allow lease conversions only to those leaseholders committed to tar sand development and to avoid speculative holding of leases.

However, tar sand development is still in a largely conceptual stage. Industry must perform further exploration to provide data on the quantity and quality of the tar sand resource, research on processing techniques, and pilot testing of those technologies which appear to be promising.

In order to meet the legislative requirements allowing for lease conversion, and also provide some flexibility for applicants, a policy of phased approval was developed by the BLM. Under this policy, all plans of operations must include a development program as required by the regulations (43 CFR 3140.2-3(f)), but the applicant may provide less detail on the development phases than is required for the exploration phases. However, the analysis by the federal agencies must consider all phases of the development. Therefore, the BLM must analyze diligence and reasonable protection of the environment, and the NPS must make its finding with respect to no resulting significant adverse impacts, based on the entire plan of operations. This analysis enables decision makers to act on the conversion with information on the type and scale of impacts anticipated from the development. As industry's plans become more concrete, modifications of the plan will be made, each probably necessitating additional environmental and technical reviews. If any of the leases are converted, the new combined hydrocarbon lease could be issued with explicit requirements for additional reviews and findings before any development on the lease could be initiated.

This strategy of phased reviews of the development components could result in increased flexibility for the industry and government. It would guarantee a significant and continuing role for both NPS and BLM in the operation of the leases and the development of the tar sand industry if the initial hurdle of lease conversion is passed. However, this strategy of phased review does not relieve the NPS of its responsibility (per 43 CFR 3140.7) of finding that lease conversion, and the consequences that could logically be expected to flow from that act (including eventual commercial-scale development), would not have a resulting significant adverse effect on the resources and administration of Glen Canyon National Recreation Area or Canyonlands National Park as a precondition for any lease conversion at all. The phased review strategy does not prevent either the BLM or the NPS from determining on the basis of information in the plan of operations that a lease cannot be converted, given present knowledge about the potential effects of the development.

AGENCY RESPONSIBILITIES AND MANDATES

The conversion process for the leases under consideration in this application involves some unique considerations, as two separate agency actions (by the BLM and the NPS) are required before leases can be converted within Glen Canyon National Recreation Area. Although both the BLM and the NPS are agencies of the Department of the Interior, each has a unique set of mandates and responsibilities. To aid in an understanding of the interplay of these responsibilities, a brief discussion of the history and mandates for each agency is included.

Bureau of Land Management

The BLM was established in 1946 as the principal management agency for the public lands. In 1976, the Federal Land Policy and Management Act (FLPMA) (43 USC 1701) was passed to provide a comprehensive charter for BLM's responsibilities--among them development of a land use planning process for public lands; management of public lands on the basis of multiple use and sustained yield; public land management to protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; and management that recognizes the nation's need for domestic sources of minerals. As a part of its responsibilities, the BLM issues federal mineral leases and is responsible for administering and regulating all lease operations (except royalty accounting). The BLM uses its established system of multiple use tradeoffs to analyze environmental effects in the context of existing laws and regulations (such as the National Environmental Policy Act, the Clean Air Act, the Clean Water Act, and the Endangered Species Act) and in consultation with agencies and bureaus with defined responsibilities under those specific laws.

National Park Service

The NPS was established by the National Park Service Organic Act of August 25, 1916 (16 USC 1), which sets out the basic mandate for the NPS to "conserve the scenery and the natural and historic objects and the wildlife [within NPS units] and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." This general conservation mandate is supplemented and expanded in the enabling legislation or orders for each NPS unit. Though the enabling legislation for some units of the national park system allows for mineral disposition and development, those uses are subordinate to the primary goals of the use and enjoyment of the resources of that unit by the public as a whole. The NPS evaluates mineral disposition, use, or development proposals against the primary purpose for which the unit was included in the national park system, taking into account the requirements of other laws and regulations (including the National Environmental Policy Act, the Clean Air Act, the Clean Water Act, and the Endangered Species Act) and in consultation with agencies who have specific responsibilities under those laws.

SPECIAL CONSIDERATIONS AND ISSUES

In addition to the interplay of differing agency mandates and responsibilities, there is an interplay of other management and legislative requirements and considerations that will affect the decision on whether or not to convert leases.

Wilderness

The FLPMA directed the BLM to inventory and review roadless areas to determine their suitability for wilderness designation. Wilderness qualities are defined in the Wilderness Act:

> . . . an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value (43 USC 1782).

Areas judged to have the above qualities and to be suitable for wilderness designation as determined by the BLM's inventory and review process qualify as wilderness study areas (WSAs). These areas remain in WSA status until such

time as Congress acts to declare them as wilderness or to release them to multiple use management. There are portions of three BLM WSAs within the federal lease unit proposed by the applicants for the Tar Sand Triangle.

Until the WSAs are acted upon by Congress, the BLM is required to manage the WSAs in accordance with a nonimpairment standard: "during the period of review and until Congress has determined otherwise, the Secretary shall continue to manage such lands...in a manner so as not to impair the suitability of such areas for preservation as wilderness, subject, however, to the continuation of existing mining and grazing uses and mineral leasing in the manner and degree in which the same was being conducted on the date of approval of this Act" (43 USC 1782). The statute requires the Secretary to take any action necessary to prevent unnecessary or undue degradation of the lands and their resources or to afford environmental protection.

The nonimpairment standard is, therefore, not absolute. It allows the Secretary to make management decisions to ensure that no future use or combination of uses will foreclose suitability as wilderness prior to Congressional action on wilderness designation. But the identification of areas having wilderness characteristics "shall not, of itself, change or prevent change in the management or use [of such public lands]." For WSAs that contain leases that may be eligible for conversion (including those within the proposed federal lease unit), the Office of the Solicitor (USDI 1983) has found that lease conversion within WSAs does not, in and of itself, violate the nonimpairment management standard. The BLM must, however, determine whether each specific action would meet the requirements of the nonimpairment standard by ensuring that its action would not result in permanent, irreversible changes to the lands that would affect their suitability for wilderness designation.

Glen Canyon National Recreation Area

Glen Canyon National Recreation Area was established in 1972 in the "rough and beautiful canyon country of the Colorado Plateau...to preserve scenic, scientific, and historical values contributing to the public enjoyment of the area." Lands in the Orange Cliffs area (some of which are included in the proposed federal lease unit currently under review) were added to the national recreation area " to provide a buffer to the Maze [a district within Canyonlands National Park] and allow the National Park Service to supervise the overlook area of Canyonlands National Park, and to develop appropriate campsites, hiking trails, and other access to the west side of the park [Canyonlands National Park]." Congress considered recreation to be the primary purpose for establishing Glen Canyon National Recreation Area, and provided that all other uses (notably grazing and mineral development) were to be "subject to the basic recreational objectives" (Sen. Rept. 92-156).

Lands within Glen Canyon National Recreation Area were withdrawn from location, entry, and patent under the general mining laws, but the Secretary may permit the removal of nonleasable and leasable minerals (under regulation) if "he finds that such disposition would not have significant adverse effects on... the administration of the national recreation area" (16 USC 460dd-2(a)).

Canyonlands National Park

The scenery and spectacular views from and within Canyonlands National Park were among the primary reasons for the park's establishment. The Committee Reports that accompanied the legislation creating and adding to Canyonlands National Park (16 USC 271, as amended) refer to the area as the "scenic heart of the Colorado plateau," and state that its "scenery alone makes this. . .unit of national significance," and "surrounding the...park area, between its boundary and the plateau rims on the east and west, are many more outstanding features--the Sixshooter Peaks, Cleopatra's Chair, the Elaterite Butte, the Orange Cliffs...and others which will be landmarks for centuries to come."

Canyonlands National Park is not open to mineral disposition under either the general mining laws or the mineral leasing laws. However, the CHLA (30 USC 181) and the implementing regulations (43 CFR 3140) contain a provision that a finding be made not only as to effects on Glen Canyon National Recreation Area, but on "contiguous units of the national park system" (43 CFR 3140.7). Thus, in considering whether lease conversions within Glen Canyon National Recreation Area, as proposed by the applicants, would have any effect, a specific finding must also be made for Canyonlands National Park.

The Combined Hydrocarbon Leasing Act

The CHLA specifically addresses Glen Canyon National Recreation Area and other units of the national park system in section 9(b)(11), saying, "the Secretary shall apply the provisions of this Act to the Glen Canyon National Recreation Area...in accordance with any applicable minerals management plan if the Secretary finds that there will be no resulting significant adverse impacts on the administration of...such area, or on other contiguous units of the National Park System [emphasis added]."

The finding required by the CHLA is thus broader than that required by the Glen Canyon National Recreation Area enabling legislation; it directs the analysis of potential effects from combined hydrocarbon leasing not only in Glen Canyon National Recreation Area, but, in this case, in Canyonlands National Park as well. This requirement, coupled with the requirements of the enabling legislation for Glen Canyon National Recreation Area and the legislative history of the Orange Cliffs area and Canyonlands National Park, makes it clear that the Congress was concerned with maintaining resource values in those NPS units while promoting tar sand leasing and development in the region. The reference in the CHLA to effects on contiguous units of the national park system requires that the finding of no resulting significant adverse effects be made for both Glen Canyon National Recreation Area and Canyonlands National Park before the NPS can consent to any lease conversions within the National Recreation Area.

NPS Finding of No Resulting Significant Adverse Impact

The Regional Director of the National Park Service must make a finding of "no resulting significant adverse impacts" on the resources and administration of

the Glen Canyon NRA and the contiguous units of Canyonlands and Capitol Reef National Parks before a lease can be converted within the NRA. The Director of the National Park Service will be issuing a directive to the Regional Director of the Service's Rocky Mountain Region on the definitions, decision criteria and procedures to be used in determining whether she could make this finding in regard to the consortium's proposed lease conversions within the Glen Canyon NRA. The Service published the draft directive in the Federal Register on May 7, 1984 and requested the public to submit comments within 30 days (see 49 FR 19438). The directive, as described below, was prepared prior to the close of the public comment period on June 7, 1984.

The directive is intended to insure that the Regional Director's finding is thorough and objective and that park resources and visitor values are protected. From a procedural point of view, it divides the Regional Director's finding on the consortium's proposal into two separate components: (1) a technical analysis of the resource impacts and the administrative effects on the NRA and on the contiguous units that result from the proposed development activities ensuing from the proposed lease conversions, and (2) a management determination as to whether those effects constitute a significant adverse impact within the meaning of the Combined Hydrocarbon Leasing Act of 1981. The technical analysis of the effects of the consortium's proposal will be performed by technical staff within the Service. It will be based upon information contained in the proposed plan of operations. The management determination of whether a significant adverse impact results from those effects will be the responsibility of the Regional Director. That determination will be made based upon a careful review of the technical analysis in light of the management responsibilities of the National Park Service.

In determining whether the proposed tar sand development results in no significant adverse impacts to the resources or administration of Glen Canyon NRA or the contiguous units, the Regional Director must give careful consideration as to whether, and to what extent, any issues or impacts identified in the technical analysis would conflict with the management responsibilities of the National Park Service. An impact shall be deemed to be a significant adverse impact when that impact or combination of impacts is of such magnitude, scope, location, timing, extent, frequency or duration that the Regional Director concludes that the impact or combination of impacts conflicts with the preservation of the resources, values or attributes of a park unit, or portion thereof, for present or future visitors.

The three decision criteria to be used in making the finding as to whether or not tar sand development as set forth in the consortium's conversion application results in a significant adverse impact are as follows:

1. Can it reasonably be anticipated that the proposal as submitted by the consortium will result in impacts that would violate a mandatory responsibility or interfere with the purposes for which the Glen Canyon NRA or the contiguous national parks were established or are managed? This would include any violation or likely violation of applicable statutes (e.g., the Service's 1916 Organic Act, Combined Hydrocarbon Leasing Act of 1981, enabling legislation of the Glen Canyon NRA, Clean Air Act, Endangered Species Act, National Historic Preservation Act), regulations, or established NPS management policies (e.g., Statement for Management, General Management Plan, Resource Management Plan, Minerals Management Plan).

Examples of this type of impact would include, but are not limited to, an unacceptable impact on an endangered species, an unacceptable impact on a National Historic Landmark, a violation of a National Ambient Air Quality Standard established under the Clean Air Act, or a conversion proposal within an excepted minerals development area as articulated in the minerals management plan.

2. Can it reasonably be anticipated that the proposal as submitted by the consortium will result in impacts that would change the character of the land, a single resource or resources of the NRA or the contiguous units to such a magnitude or extent, or occurring with such timing (i.e., daily or seasonal), or frequency, or duration, or at such location that the impact or impacts would diminish the resource values for which the NRA or the contiguous units were established? Examples of this type of impact would include, but are not limited to, the destruction of scenic panorama whose value is judged to be of national significance, on the destruction of a species habitat that is integral to the unit, or a repeated smoke plume visible during the peak visitor season of either the NRA or contiguous national parks.

3. Can it reasonably be anticipated that the proposal as submitted by the consortium will result in a number of impacts that, when considered cumulatively or synergistically, would change the character of the lands or resources or quality of the visitor experience (i.e., present and future) within Glen Canyon NRA or the contiguous units? As in #2 above, the Regional Director must consider the magnitude, extent, location, timing (i.e., daily and seasonal), frequency, and duration of these individual, cumulative and synergistic effects. Examples of this type of impact would include, but are not limited to, where the cumulative effects of noise, odor, and visual intrusion change the basic character of an important resource area of the NRA or are judged to result in an unacceptable change in recreational opportunities.

If the proposed tar sands development activities would cause a violation of the type specified in the first criterion, the Regional Director must make a mandatory finding of a significant adverse impact. If the consortium's proposal results in an impact of the type specified in either of the other two criteria, the Regional Director will make a reasoned judgment, based on the best available information, as to whether the impact is deemed to be a significant adverse impact as defined in the directive.

After reviewing the technical analysis and applying the decision criteria, the Regional Director must notify the Bureau of Land Management in writing that the National Park Service denies or grants its consent to the issuance of combined hydrocarbon leases to the consortium. In so notifying the Bureau of Land Management, the Regional Director also needs to forward complete documentation that substantiates her determination so that the Bureau can incorporate the information into its record of decision on the proposed application. Timely notice of the Regional Director's finding and the availability of supporting documentation will be published in the Federal Register and in local newspapers.

SCOPE OF THE ANALYSIS

The EIS addresses the effects of converting existing oil and gas leases within the proposed federal lease unit to combined hydrocarbon leases and allowing development of the tar sand resource associated with the leases. As previously discussed, a decision to convert the leases must consider the environmental consequences resulting from the applicants' proposed commercial development of the tar sand resource as well as the lease conversion itself. BLM and NPS will use this EIS to aid in making their required determinations: reasonable protection of the environment and a finding of no resulting significant adverse impact, respectively. These determinations are prerequisites to the issuance of combined hydrocarbon leases to the applicants.

As required by the Act, the NPS cannot consent to the proposed lease conversions and subsequent development of the tar sand resource within Glen Canyon NRA without first making a finding that no resulting significant adverse impacts would occur to the administration or resource values within the NRA and any contiguous NPS units (i.e., Canyonlands NP). In making such a finding, the Service must analyze the effects of subsequent commercial development of tar sand resources associated with the converted leases. In order to evaluate the effects of selected mitigation measures, this EIS contains an analysis of various development restrictions that might be adopted to protect resources and that could be applied to reduce impacts.

INTERRELATIONSHIP WITH OTHER PROPOSALS

There are currently no existing or authorized projects in the vicinity of the Tar Sand Triangle proposed federal lease unit. The proposed lease conversion is a site-specific plan based on existing lease conversion applications rather than a new competitive leasing effort. If the leases within the proposed operating unit are not converted, the area could be opened to competitive leasing at some time in the future. Projects that may be associated with competitive leasing for all STSAs are discussed in the BLM Utah Combined Hydrocarbon Leasing Regional EIS; the final EIS will be released in June 1984. Five tar sand development proposals connected with lease conversion applications and development proposals have been submitted for lands in the Sunnyside STSA, north of Green River, Utah, and are being analyzed by the BLM in a similar EIS. The final EIS will be finished in August 1984 for Sunnyside. In addition, a proposal for lease conversions has been received for leases within the Circle Cliffs STSA, south and west of the proposed Tar Sand Triangle project; the BLM will also analyze this proposal in a draft EIS scheduled for completion in October 1984.

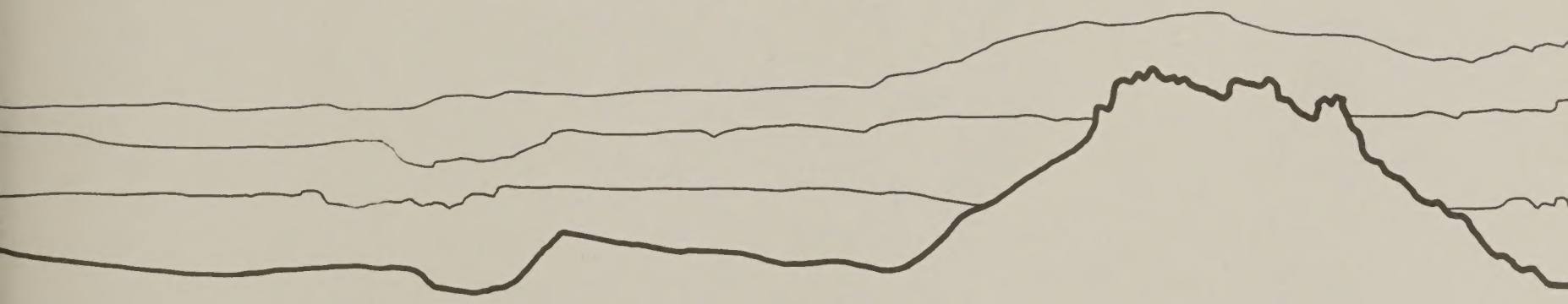
Since this DEIS was initiated four additional applications for conversion have been received by the BLM within the Tar Sand Triangle STSA. The applications are from the following:

William C. Kirkwood	- 26 leases	- 46,013 acres
Morton M. Pepper	- 1 lease	- 1,280 acres
Maurice W. Brown	- 1 lease	- 440 acres
Sohio Oil Shale	- 2 leases	- 3,496 acres
Total	30 leases	- 51,229 acres

These applications will be analyzed by the BLM in a future EIS.

In addition to tar sand leasing or conversion projects planned for the Tar Sand Triangle area, the Utah BLM is planning to analyze the suitability of the WSAs for wilderness designation in a statewide wilderness EIS (the draft is currently scheduled for release in May 1985).

ALTERNATIVES INCLUDING THE PROPOSED ACTION



OVERVIEW OF THE ALTERNATIVES

This section of the DEIS presents a brief description of the alternatives considered but eliminated from detailed study; a description of each alternative, including the proposed action; an evaluation and comparison of the alternatives; and the rationale for why a preferred alternative has not been selected at this time.

The alternatives were refined throughout the scoping and environmental process and are presented for analysis, as follows:

Alternative 1: Convert all Leases (Proposed Action)

Alternative 2A: Convert Leases With Additional Protective Restrictions

Alternative 2B: Deny Conversion on BLM Wilderness Study Area (WSA) Lands; this alternative is similar to alternative 2A except leases within WSAs would not be converted

Alternative 2C: Deny Conversion on NPS National Recreational Area (NRA) Lands; this alternative is also similar to alternative 2A except leases within Glen Canyon National Recreation Area would not be converted

Alternative 3: Deny Conversion of all Leases (No Action)

Alternatives 1, 2A, 2B, and 2C each would have four phases of development, as follows:

exploration and delineation (phases I and II)
pilot (phase III)
commercial (phase IV)

ALTERNATIVES CONSIDERED BUT ELIMINATED

This DEIS was prepared in response to a specific proposal using a particular technology by nongovernmental applicants; therefore, alternative extraction and refining technologies were not considered. Various combinations of extraction techniques (mining and in-situ) and upgrading technologies known to exist could yield over 40 possible development scenarios. It was not practical to evaluate all possible combinations of extraction and upgrading techniques in detail. To facilitate an analysis of the environmental consequences that could be expected to flow from lease conversions, modifications of the applicants' proposed production scenario and combinations of lease conversion and denying conversion were discussed. Discussions of other technologies would necessitate a redesign of the applicants' proposal and, as such, were not considered as a helpful analytical tool in determining the consequences of lease conversions.

DESCRIPTION OF THE ALTERNATIVES

ALTERNATIVE 1: CONVERT ALL LEASES (PROPOSED ACTION)

The proposed action to convert existing oil and gas leases to combined hydrocarbon leases within 54,546 acres of the 66,040-acre unit originally proposed (see figure 3) is based on the plan of operations submitted by the applicants. Leases eligible for conversion under alternative 1 are presented in table 1 and on figure 4.

The plan of operations discusses four development phases. Phases I and II would be exploratory, involving the drilling of coreholes. Phase III would be a pilot-scale in-situ extraction and upgrading process (an estimated maximum of 500 barrels per day [bpd] of extracted bitumen). Phase IV would be a full-scale commercial extraction program using in-situ steam injection methods, allowing for a maximum production level of 30,000 bpd of extracted bitumen, and including an onsite upgrading facility.

Phase I would include the drilling of 2 coreholes (in 1984) in the Gordon Flats area using air drilling methods (see figure 5). Access would be via the existing Flint Trail and by small plane (using the existing airstrip at Gordon Flats).

Phase II would involve the drilling of up to 15 coreholes (in 1985 and 1986) using air drilling methods. Main access would be via the Flint Trail, and the construction of approximately 12 miles of temporary roads would be required (see figure 6).

Phase III construction and operation would occur from 1986 through 1988. Two adjacent inverted five-spot well patterns would be drilled in the Gordon Flats area. An inverted five-spot consists of a central injection well and four production wells. A portable steam generator (burning fuel oil) would be used to generate steam for the extraction process. An average of 180-200 bpd of bitumen would be extracted and removed to an offsite laboratory for testing; the bitumen extraction rate is not expected to exceed 500 bpd. Main access would be via the existing Flint Trail; some road upgrading (possibly including paving) would be necessary during phase III. Water would be obtained from two wells drilled in sec. 22, T30S, R16E, and wastewater would be reinjected into a suitable underground formation.

Phase IV construction would begin in 1990, and commercial operations would commence in 1994, achieving the full production level of 30,000 bpd in 1995. Best available control technology (BACT) would be applied to reduce air emissions. Large-scale steam generation facilities would be required, and because steam cannot be transported over great distances, the steam generation facilities would be moved throughout the federal lease unit as development progresses over time. Water for steam generation (1,679 acre-feet/year) would be pumped via pipeline approximately 12 to 15 miles from the Dirty Devil River. Silt

would be removed and the water would be treated onsite. Water would be recovered and reused to the maximum extent possible, but an estimated 1,050 gallons per minute (gpm) of makeup water would be required. An estimated 150 gpm of wastewater would be reinjected into a suitable but yet unidentified underground formation.

Unit development would occur sequentially through 23 prospective areas identified as the principal extraction zones by the applicants (see figure 3). Five of these areas (prospective areas #18-#22) lie partially within the area closed to mineral disposition and are not considered in this analysis.

Prospective area #1 (the initial extraction zone) would be located in the Gordon Flats area, and the development would move through the remaining 18 prospective areas over time. Major development activities would thus primarily take place on 38,790 acres lying within the 18 extraction zones. As bitumen from each area is exhausted, the area would be reclaimed and a new extraction zone developed. Because the bitumen cannot be transported via conventional pipeline and is not acceptable as refinery feedstock in its raw form, a refinery-type upgrading facility would also be located at Gordon Flats (see figure 7). This facility would serve a twofold purpose--the facility would upgrade the bitumen sufficiently to allow transportation and acceptance by refineries and would produce coke as fuel for steam generation. The upgrading facility would not be moved during the life of the project.

Major access would be via the Flint Trail, which would be widened, upgraded, and paved (if not already done as a part of phase III). The acreage required for wellfields, steam and bitumen pipelines, utilities, service roads, and other ancillary facilities would vary over time, depending upon the exact configuration and location of such facilities, and the maximum acreage required at any one time would be 1,400 acres (340 acres of new construction, 890 acres of active extraction zone, and 170 acres of new reclamation). Syncrude would be transported to market by a pipeline of as-yet undetermined design and alignment along one of two possible routes.

Table 2 contains a summary of the proposed action. A more detailed description of the proposed four-phased development is in appendix A; tar sand exploration and upgrading technologies are presented in appendix B.

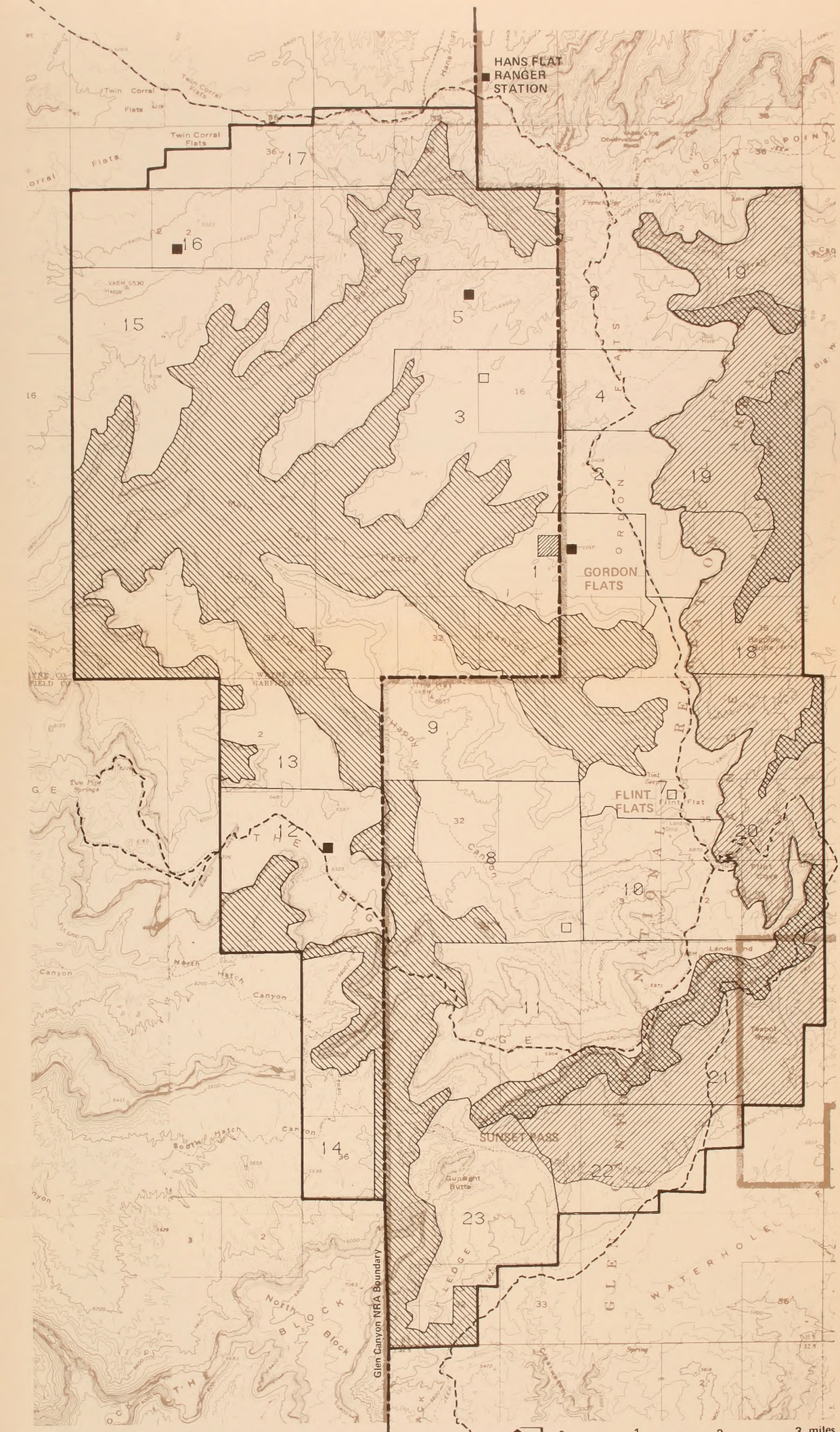

HANS FLAT RANGER STATION
GORDON FLATS
FLINT FLATS
SUNSET PASS
Glen Canyon NRA Boundary
7
Prospective areas for sequential development (extraction zones)
Area where extraction cannot occur (to be verified by field testing)
Proposed steam boiler locations
Alternate boiler locations
Upgrading plant
Area closed to mineral disposition within Glen Canyon National Recreation Area
north
0 1 2 3 miles
0 1 2 3 kilometers

Fig. 3.. Alternative 1: Convert all Leases

TST	40002
DSC	NOV 83

Table 1: Leases Eligible for Conversion

Map Index Number	Land Description	Acres	Serial Number	Expiration Date of Lease	Lessee of Record
FEDERAL LANDS					
FL51	T30-R16E, S.L.M. Sec. 19: S½	320	U-0108406-A	5-31-75 (in suspense)	Santa Fe Energy Company
FL52	T30S-R16E, S.L.M. Sec. 3: SW¼SE¼	40	U-0144313	12-31-74 (in suspense)	Santa Fe Energy Company
FL1	T30S-R16E, S.L.M. Sec. 18: N½	320	U-934	9-30-76 (in suspense)	Santa Fe Energy Company
FL2	T30S-R16E, S.L.M. Sec. 21: all	640	U-2521	3-31-77 (in suspense)	Santa Fe Energy Company
FL5	T30S-R16E, S.L.M. Sec. 13: SW¼SE¼ E½SE¼ Sec. 14: W½E½, W½ Sec. 23: W½W½ Sec. 26: W½W½ Sec. 35: W½W½	1,080	U-2754	5-31-82 (in suspense)	Altex Oil Corporation
FL6	T30S-R16E, S.L.M. Sec. 15: all	640	U-2755	4-30-77 (in suspense)	Santa Fe Energy Company
FL7	T30S-R16E, S.L.M. Sec. 22: NW¼	160	U-2756	4-30-77 (in suspense)	Santa Fe Energy Company
FL3	T30S-R16E, S.L.M. Sec. 10: all Sec. 20: all	1,280	U-4444	12-31-77 (in suspense)	Santa Fe Energy Company
FL8	T30S-R16E, S.L.M. Sec. 17: E½ Sec. 19: NE¼ Sec. 29: NE¼NE¼ T30½S-R16E, S.L.M. Sec. 24: all	674	U-4585	1-31-78 (in suspense)	Santa Fe Energy Company
FL9	T30S-R16E, S.L.M. Sec. 8: all	640	U-4659	1-31-78 (in suspense)	Santa Fe Energy Company
FL10	T30S-R16E, S.L.M. Sec. 1: all Sec. 30: all	1,280	U-5131	2-28-78 (in suspense)	Santa Fe Energy Company

Map Index Number	Land Description	Acres	Serial Number	Expiration Date of Lease	Lessee of Record
FL11	T30S-R16E, S.L.M. Sec. 3: N½, N½SE¼, SE¼SE¼, SW¼	598	U-7167	4-30-79 (in suspense)	Santa Fe Energy Company
FL12	T30S-R16E, S.L.M. Sec. 31: all	640	U-7648	5-31-79 (in suspense)	Santa Fe Energy Company
FL13	T30S-R16E, S.L.M. Sec. 17: N½NW¼	80	U-8291	5-31-79 (in suspense)	Santa Fe Energy Company
FL14	T30S-R16E, S.L.M. Sec. 4: all Sec. 9: all	1,279	U-8291-A	5-31-79 (in suspense)	Santa Fe Energy Company
FL15	T30S-R16E, S.L.M. Sec. 14: NE¼NE¼	40	U-8291-F	5-31-79 (in suspense)	Santa Fe Energy Company
FL50	T30S-R16E, S.L.M. Sec. 25: SW¼	160	U-8291-G	5-31-79 (in suspense)	Benson-Montin-Greer Drilling Corporation
FL16	T30S-R16E, S.L.M. Sec. 13: E½NE¼, SW¼NE¼, W½, NW¼SE¼ Sec. 14: SE¼NE¼, E½SE¼ Sec. 23: E½, E½W½ Sec. 24: all Sec. 25: NW¼	1,880	U-17781	1-31-82 (in suspense)	Benson-Montin-Greer Drilling Corporation
FL17	T30S-R16E, S.L.M. Sec. 33: all	640	U-17782	1-31-82 (in suspense)	Altex Oil Corporation
FL18	T30S-R16E, S.L.M. Sec. 22: NE¼, S½ Sec. 27: all Sec. 28: all	1,760	U-17782-A	1-31-82 (in suspense)	Santa Fe Energy Company
FL19	T30S-R16E, S.L.M. Sec. 26: E½, E½W½ Sec. 35: E½, E½W½	960	U-17783	1-31-82 (in suspense)	Altex Oil Corporation
FL20	T30½S-R26E, S.L.M. Sec. 29: N½ Sec. 30: N½N½ Sec. 33: E½ Sec. 34: N½	1,030	U-17784	1-31-82 (in suspense)	Altex Oil Corporation
FL22	T30½S-R16E, S.L.M. Sec. 30: S½N½, S½	211	U-18403	3-31-32 (in suspense)	Texaco Incorporated

Map Index Number	Land Description	Acres	Serial Number	Expiration Date of Lease	Lessee of Record
FL23	T31S-R16E, S.L.M. Sec. 15: all Sec. 22: all Sec. 27: N½N½	1,440	U-18656	6-30-82 (in suspense)	Altex Oil Corporation
FL24	T31S-R16E, S.L.M. Sec. 9: S½ Sec. 21: all Sec. 28: W½, W½E½, NE¼NE¼	1,480	U-18657	6-30-82 (in suspense)	Altex Oil Corporation
FL25	T31S-R16E, S.L.M. Sec. 17: all Sec. 20: all Sec. 29: all	1,920	U-18658	6-30-82 (in suspense)	Altex Oil Corporation
FL26	T31S-R16E, S.L.M. Sec. 19: all Sec. 30: all Sec. 31: all	859	U-18659	6-30-82 (in suspense)	Altex Oil Corporation
FL27	T31S-R16E, S.L.M. Sec. 14: all Sec. 23: N½, SW¼	1,120	U-18660	6-30-82 (in suspense)	Altex Oil Corporation
FL28	T31S-R16E, S.L.M. Sec. 13: W½, W½E½	480	U-18661	7-31-82 (in suspense)	Altex Oil Corporation
FL30	T30S-R16E, S.L.M. Sec. 12: N½S½, S½SE¼ Sec. 13: NW¼NE¼ Sec. 29: NW¼NE¼, S½NE¼, NW¼, S½	880	U-20002	7-31-82 (in suspense)	Santa Fe Energy Company
FL31	T30½S-R16E, S.L.M. Sec. 28: N½ Sec. 29: S½ Sec. 34: S½ Sec. 35: E½NE¼, S½SW¼, NE¼SE¼, SW¼SE¼	1,200	U-20292	9-30-82 (in suspense)	Santa Fe Energy Company
FL32	T30S-R16E, S.L.M. Sec. 34: all	640	U-20515	10-31-82 (in suspense)	Santa Fe Energy Company

Map Index Number	Land Description	Acres	Serial Number	Expiration Date of Lease	Lessee of Record
FL33	T30½S-R16E, S.L.M. Sec. 20: all Sec. 22: all Sec. 23: all Sec. 26: all Sec. 27: all Sec. 28: S½	2,060	U-20859	11-30-82 (in suspense)	Santa Fe Energy Company
FL34	T30½S-R16E, S.L.M. Sec. 19: all Sec. 21: all	220	U-20859-A	11-30-82	Raymond N. Joeckel
FL35	T31S-R16E, S.L.M. Sec. 3: lots 1,2 3,4, S½N½, S½ Sec. 4: E½ Sec. 9: N½	1,285	U-20860	11-30-82 (in suspense)	Benson-Montin-Greer Drilling Corporation
FL36	T31S-R15E, S.L.M. Sec. 11: all Sec. 13: all	1,280	U-21036	12-31-83	Santa Fe Energy Company
FL37	T30S-R15E, S.L.M. Sec. 27: S½ Sec. 34: N½, SE¼ Sec. 35: all	1,440	U-21084	1-31-84	Southland Royalty Company Sun Exploration and Production Company HOC 1982 Rockies Oil Program Limited Partnership Hershey Oil Corporation
FL38	T30S-R15E, S.L.M. Sec. 27: N½ Sec. 34: SW¼	480	U-21084-A	1-31-84	Raymond N. Joeckel
FL39	T30S-R16E, S.L.M. Sec. 5: all Sec. 6: all Sec. 7: all	1,919	U-21160	5-31-84	Santa Fe Energy Company
FL40	T31S-R15E, S.L.M. Sec. 1: NE¼, S½N½,8 120 acres of NW¼	481	U-21241	1-31-83	Raymond N. Joeckel
FL41	T30S-R15E, S.L.M. Sec. 10: all	640	U-21488	1-31-84	Santa Fe Energy Company

Map Index Number	Land Description	Acres	Serial Number	Expiration Date of Lease	Lessee of Record
FL42	T30S-R15E, S.L.M. Sec. 22: all	640	U-21488-A	1-31-84	Southland Royalty Company Sun Exploration and Production Company HOC 1982 Rockies Oil Program Limited Partnership Hershey Oil Corporation
FL43	T29S-R15E, S.L.M. Sec. 35: SW¼SW¼, E½SW¼, SE¼ T29S-R16E, S.L.M. Sec. 31: all T30S-R15E, S.L.M. Sec. 3: all	1,559	U-21489	1-31-84	Santa Fe Energy Company
FL44	T31S-R15E, S.L.M. Sec. 1: all (excluding 481 acres in oil & gas lease U-21241) Sec. 12: N½, SE¼	880	U-24444	12-31-83	Santa Fe Energy Company
FL45	T31S-R15E, S.L.M. Sec. 12: SW¼ Sec. 14: all Sec. 24: all Sec. 25: NE¼, N½SE¼, SW¼SE¼	1,720	U-33409	5-31-86	Lester Kabacoff Joseph J. Falgout Edgar B. Stern, Jr.
FL46	T30S-R15E, S.L.M. Sec. 23: NE¼, NE¼NW¼, S½NW¼, SW¼ Sec. 24: N½, SE¼ Sec. 25: NE¼, S½ Sec. 26: NW¼, S½	1,880	U-34345	11-30-86	Southland Royalty Company Sun Exploration and Production Company
FL47	T30S-R15E, S.L.M. Sec. 11: SE¼ Sec. 14: all	800	U-44334	12-31-89	Joseph F. Hoffman John M. Beard
FL48	T30S-R15E, S.L.M. Sec. 13: all Sec. 23: NW¼NW¼, SE¼ Sec. 24: SW¼ Sec. 25: NW¼ Sec. 26: NE¼	1,320	U-44733	2-28-90	Diane H. Schafer

Map Index Number	Land Description	Acres	Serial Number	Expiration Date of Lease	Lessee of Record
FL49	T31S-R15E, S.L.M. Sec. 25: W½, SE¼SE¼	360	U-45845	12-31-83	Raymond N. Joeckel
	T30S-R15E, S.L.M. Sec. 1: all Sec. 11: N½, SW¼ Sec. 12: all Sec. 15: all	11,145	(unleased)		Unleased
	T30S-R16E, S.L.M. Sec. 11: all Sec. 12: N½, S½SW¼ Sec. 17: S½NW¼, SW¼ Sec. 18: S½ Sec. 19: NW¼ Sec. 25: E½				
	T30½S-R16E, S.L.M. Sec. 25: all Sec. 31: all Sec. 33: W½ Sec. 35: NW¼, W½NE¼, N½SW¼, NW¼SE¼, SE¼SE¼				
	T31S-R16E, S.L.M. Sec. 1: all Sec. 10: all Sec. 11: all				
	T31S-R16E, S.L.M. Sec. 4: W½ Sec. 5: all Sec. 6: all Sec. 7: all Sec. 8: all Sec. 12: all Sec. 18: all				
Federal Tracts (49) Total (acres)		56,480 (or 85.52% of the proposed federal lease unit)			
STATE LANDS					
SL1	T30S-R16E, S.L.M. Sec. 16: N½	320	ML-21154-A	12-31-83	Santa Fe Energy Company
SL2	T30S-R16E, S.L.M. Sec. 16: S½	320	ML-24935	1-31-78 (in suspense)	Santa Fe Energy Company

Map Index Number	Land Description	Acres	Serial Number	Expiration Date of Lease	Lessee of Record
SL3	T30S-R16E, S.L.M. Sec. 32: all	640	ML-28283	12-31-84	Altex Oil Corporation
SL4	T30½S-R16E, S.L.M. Sec. 32: all	640	ML-28285	12-31-84	Altex Oil Corporation
SL5	T29S-R15E, S.L.M. Sec. 36: S½N½, S½ T29S-R16E, S.L.M. Sec. 32: all T30S-R15E, S.L.M. Sec. 2: lots 1,2,3 4, S½N½, S½	1,759	ML-29198	1-31-83	Santa Fe Energy Company
SL6	T30S-R15E, S.L.M. Sec. 36: all	640	ML-38386	7-31-90	Cordillera Corporation
SL7	T30S-R16E, S.L.M. Sec. 2: lots 1,2, 3,4, S½N½, S½	638	ML-38387	7-31-90	Hawthorn Oil Company Bryan Bell Steve Champlin Bill D. Farleigh Lee M. Grace Rush B. Locke Colman Mockler, Jr. Warren A. Morton The Ogle Corporation Wyoming National Bank, Trustee for Rex L. Randolph Keogh Account
SL8	T30½S-R16E, S.L.M. Sec. 36: all	640	ML-38389	7-31-90	Metro Energy, Incorporated
SL9	T31S-R15E, S.L.M. Sec. 2: lots 1,2, 3,4,5,6,7, 8,9,10,11, 12, S½N½, S½	880	ML-38390	7-31-90	Cordillera Corporation
SL10	T31S-R15E, S.L.M. Sec. 36: all	640	ML-38391	7-31-90	Cordillera Corporation
SL11	T31S-R16E, S.L.M. Sec. 2: lots 1,2, S½NE¼, S½	480	ML-38392	7-31-90	Altex Oil Corporation
SL12	T31S-R16E, S.L.M. Sec. 16: all	640	ML-38393	7-31-90	Altex Oil Corporation

Map Index Number	Land Description	Acres	Serial Number	Expiration Date of Lease	Lessee of Record
SL13	T31S-R16E, S.L.M. Sec. 32: W½, W½E½, NE¼NE¼	520	ML-38394	7-31-90	Maurice W. Brown
SL14	T30S-R16E, S.L.M. Sec. 36: E½, E½W½	480	ML-38395	7-31-90	Metro Energy, Incorporated
SL15	T30S-R16E, S.L.M. Sec. 36: W½W½	160	ML-40275		Altex Oil Corporation
State Tracts (15) Total (acres)		9,387 (or 14.21% of the proposed federal lease unit)			
Unleased State Tracts (acres)		173			
Federal and State Tracts (65) Grand Total (acres)		66,040 (in the proposed federal lease unit)			

Note: Map index number refers to numbers found on figure 4.

The federal tracts include 11,494 acres that are unleased or ineligible for conversion because they are within the area closed to mineral disposition by the Minerals Management Plan for Glen Canyon National Recreation Area. These areas are not considered in the impact analysis. Additional unleased tracts within the unit boundaries may be leased at some future date and may or may not be included in any authorized operating unit. However, since the applicants have included these areas within the proposed unit, the acreage is included in the impact analysis.

Leases on the state tracts are not at issue. The federal government is not required to make a decision on conversion. These leases may or may not be included in any authorized operating unit, but as the applicants have included them, the acreage is included in the impact analysis.

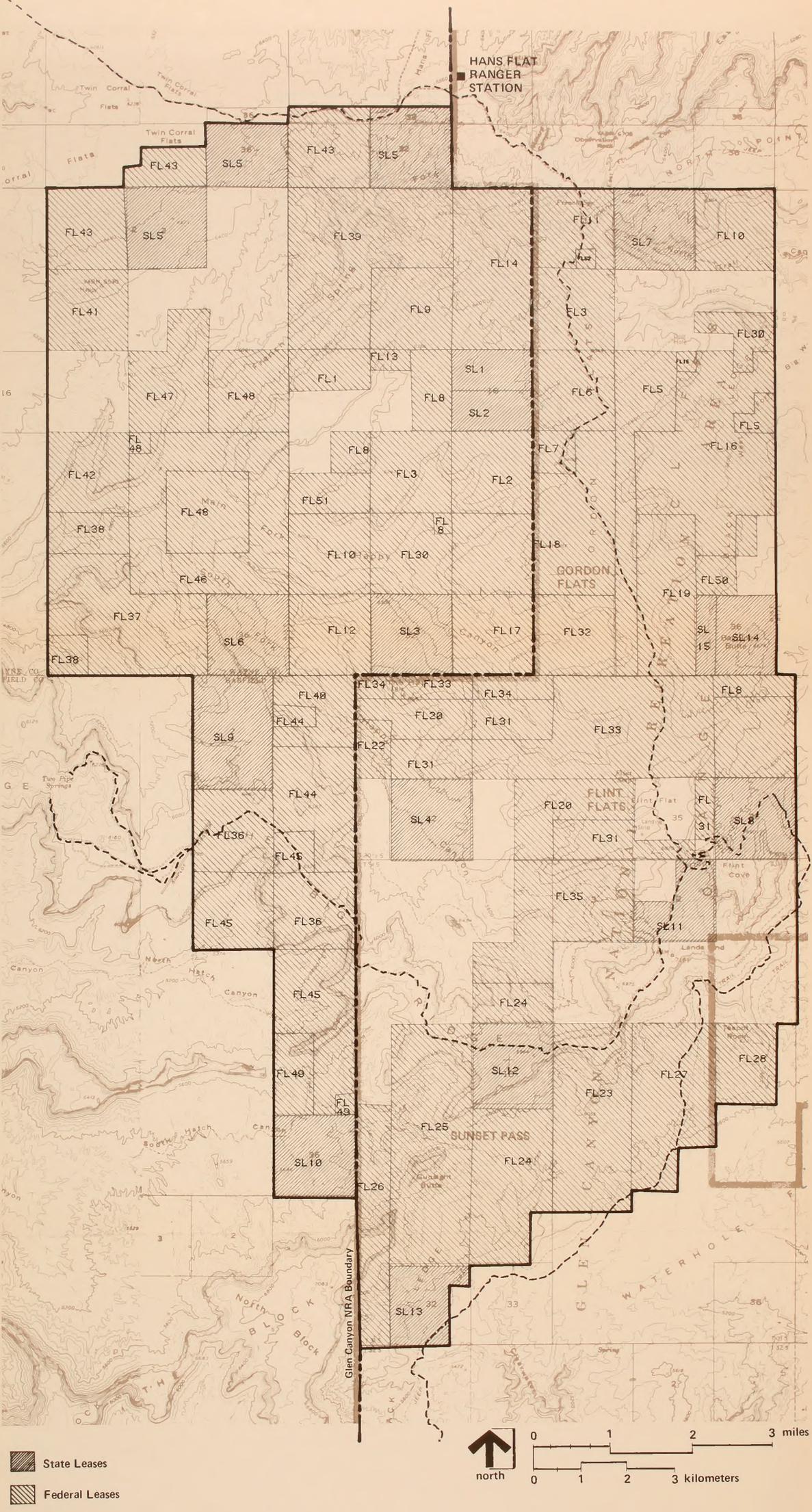


Fig. 4. Existing Federal Leases Proposed for Conversion

TST	40030
DSC	NOV 83

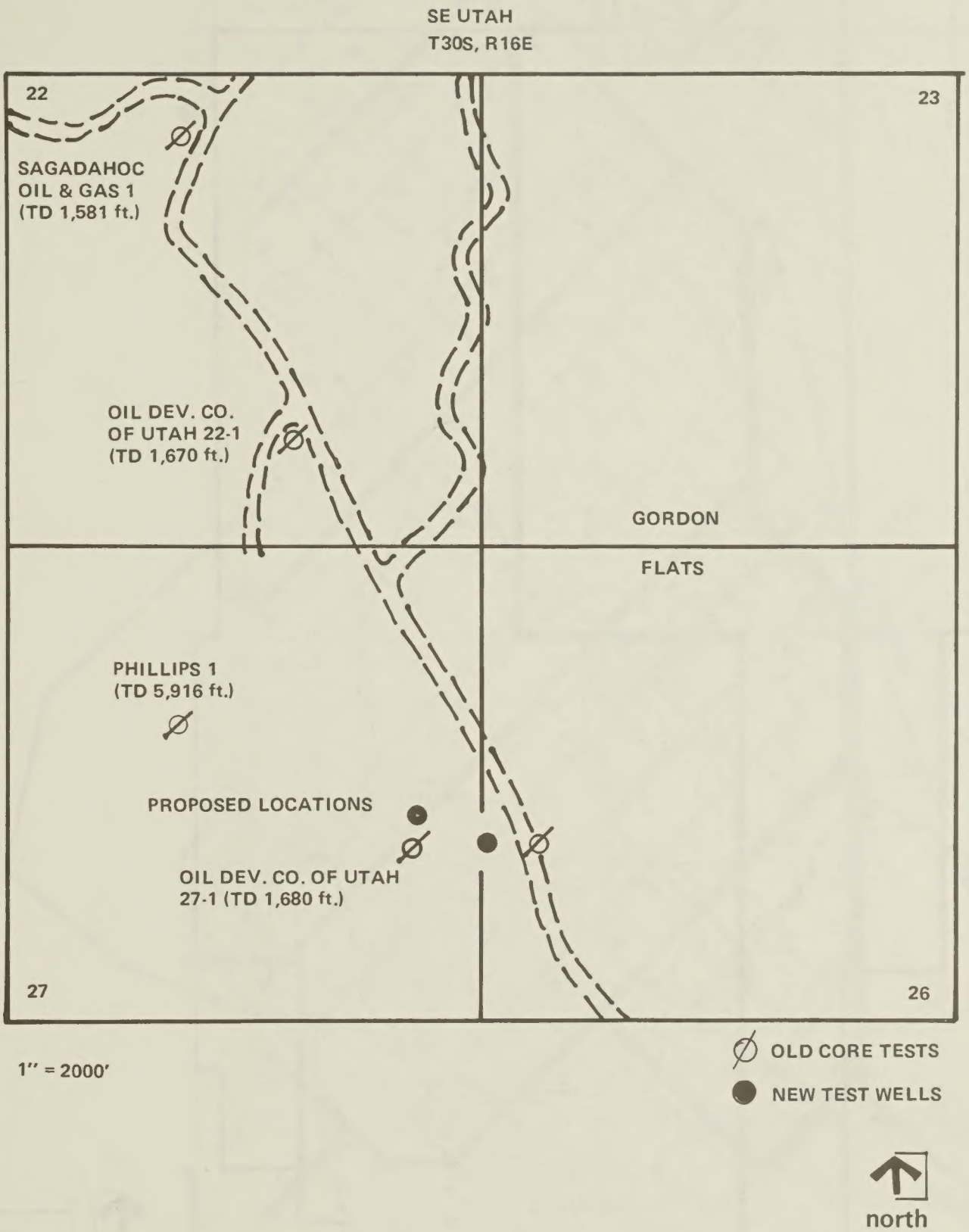
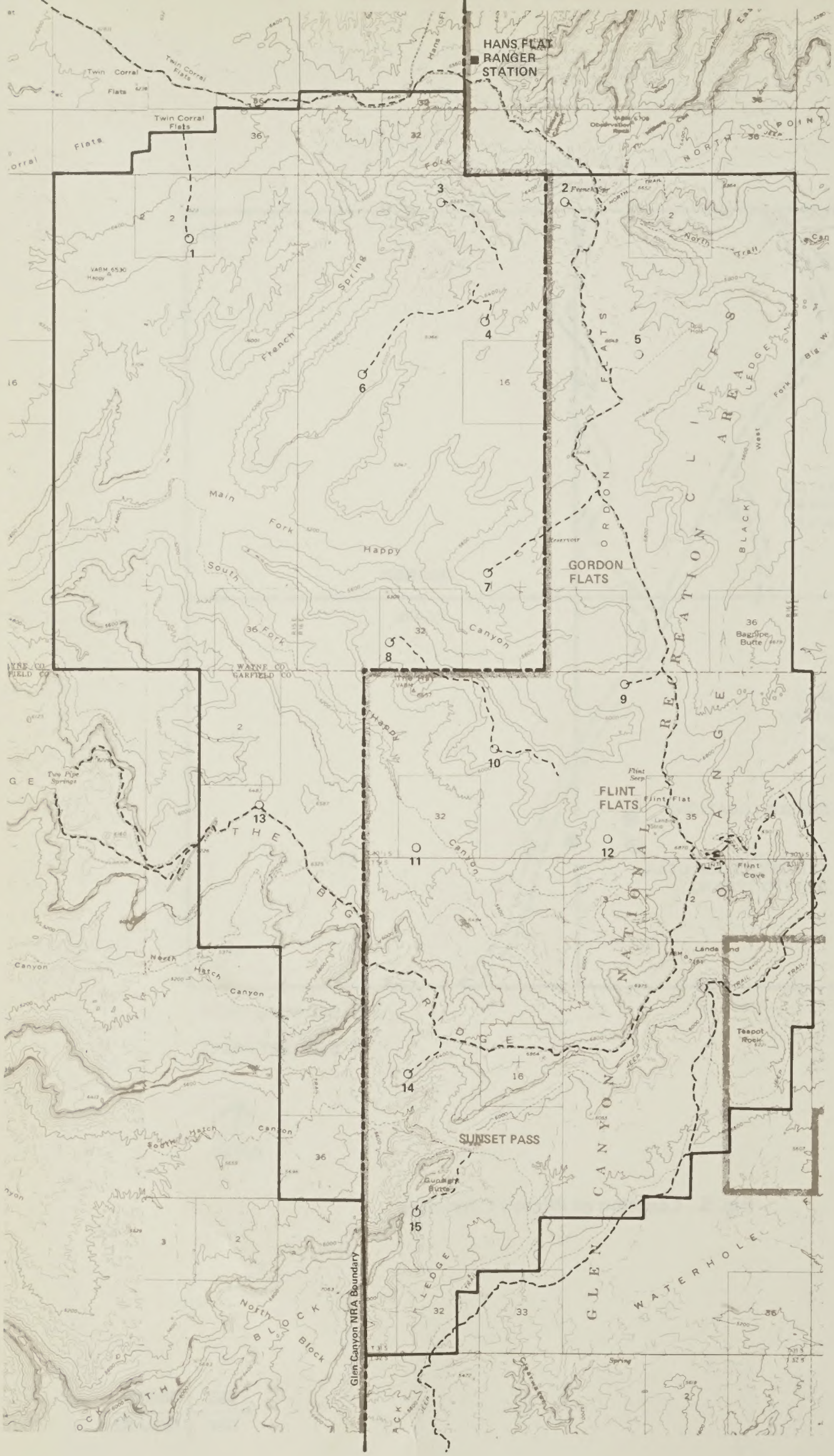


Fig. 5. Location of Phase I Coreholes

TST	40003
DSC	NOV 83



north 0 1 2 miles 0 1 2 3 kilometers

Fig.6. Phase II
Proposed Coreholes and
New Access Roads

TST	40031
DSC	NOV 8

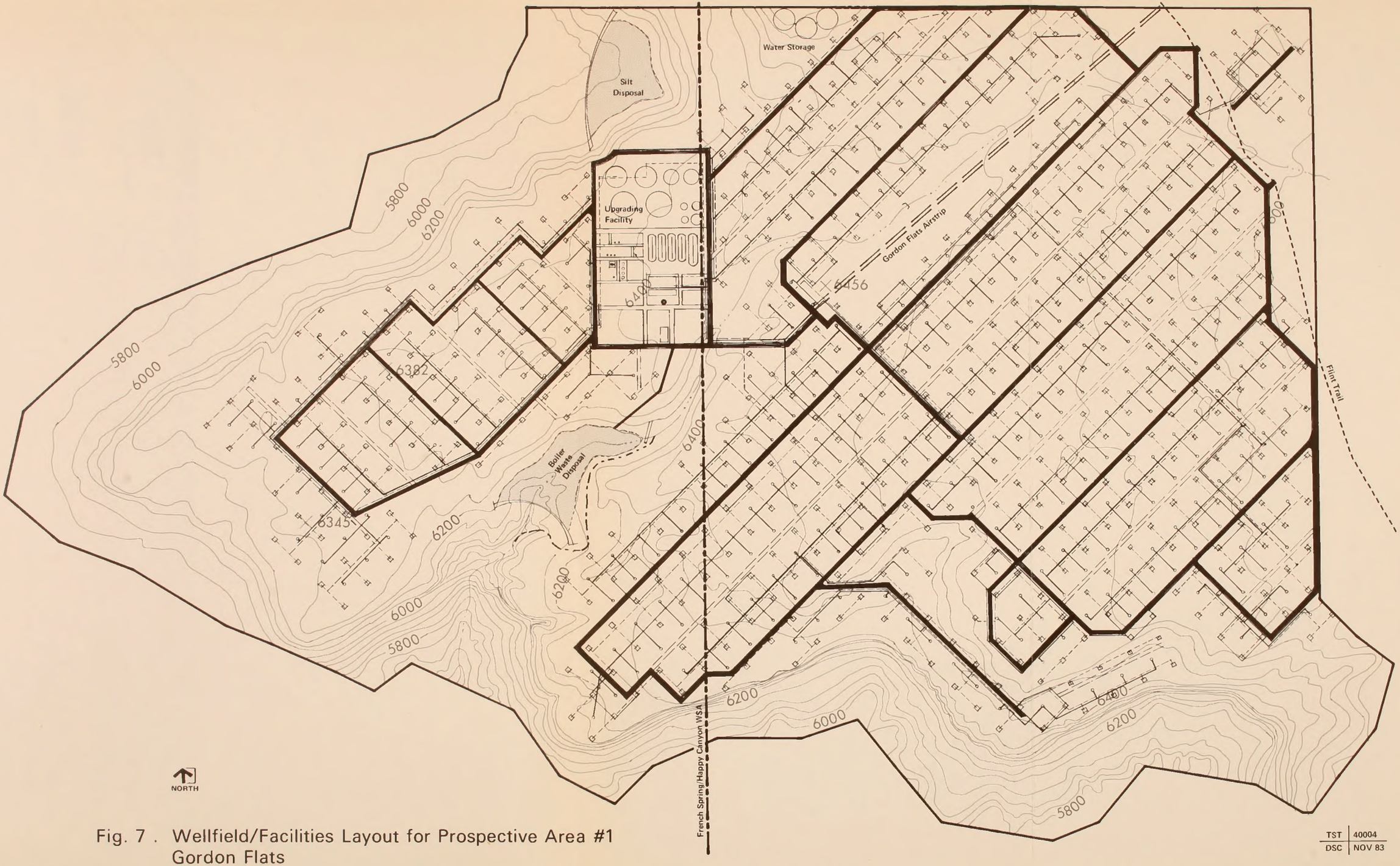


Fig. 7 . Wellfield/Facilities Layout for Prospective Area #1
Gordon Flats

TST	40004
DSC	NOV 83

Table 2: Summary of Alternative 1 Assumptions

Project Components	Development Phases I	II	III	IV
Number of wells	2 coreholes	15 coreholes	8	minimum 1,940
Injection/production wells	NA	NA	2 inj/6 prod	940 inj/1,000 prod (min. per prospective area)
Miles of major new access (within lease unit)	none	12 (temporary access trails)	none	27
Area disturbed for extraction processing, and ancillary facilities	2 acres	up to 15 acres	15-20 acres	up to 38,790 acres (1,400 acres at one time)
Peak workforce	7	7-10	57	2,400
Duration of project	15 days	75 days	2 years	up to 160 years
Production rate	NA	NA	up to 500 bpd	up to 30,000 bpd
Extraction type	NA	NA	in-situ steam-drive	in-situ steam-drive
Equipment	NA	NA	2 steam boilers	fluidized bed combustion units
Fuel source	diesel	diesel	fuel oil	coke
Water source	trucked in	trucked in	local wells	Dirty Devil River and local wells
Water requirement	NA	minimal	94 acre-ft/yr	1,697-acre-ft/yr
Upgrading plant	NA	NA	offsite	delayed coking
Waste production	NA	onsite disposal pit at each drill site	unknown	sulfur 100 short T/day solid 970 yd^3/day water 150 gpm
Product transport	NA	NA	truck	truck/pipeline

Note: Phase IV project components are for each of the 18 prospective areas.

ALTERNATIVE 2A: CONVERT LEASES WITH ADDITIONAL PROTECTIVE RESTRICTIONS

Conversion of the existing oil and gas leases to combined hydrocarbon leases contemplates that development would be allowed. Performance restrictions developed to protect the critical resource values identified in this document as being at risk would be included in the lease. These restrictions would include the Department's right to perform further environmental revisions as the proposal prepares to move into later phases. Approval for the applicants to move into later phases would depend upon their ability to meet those identified performance standards.

Inclusion of alternative 2A in the DEIS does not ensure that such an alternative would be technically or economically viable. Those determinations would be dependent upon results of exploration and on further project design adjustments by the applicants as the project plans are refined in the future. Such determinations are not essential to the DEIS analysis, which is focused on the reasonable environmental protection criteria of the Combined Hydrocarbon Leasing Act as applied to BLM lands, and the finding of no significant resulting adverse impact as applied to NPS lands. Alternative 2A would convert leases within 54,546 acres of the proposed federal lease unit (see figure 8). Alternative 2A assumes a substantially lower ultimate production rate--5,000 bpd rather than 30,000 bpd proposed by the applicants. The lowered production level was chosen for analytical purposes only. A lower production rate provides a comparison with the alternative 1 production level and allows quantification of the resulting difference in impacts related to the intensity of development; it is not an attempt to specify a restriction on production rates. For purposes of this analysis, extraction and upgrading techniques were assumed to be the same as those proposed in alternative 1. Table 3 lists the major production assumptions applied as a part of the analysis of alternative 2A.

Protective restrictions to reduce impacts, whether technical, administrative, or environmental, were applied to the analysis of alternative 2A (see table 4). The restrictions in table 4 specifically protect the geographic resources in the proposed federal lease unit. These sensitive resources would constrain development on 31,000 acres and would include steep slopes, archeological sites, cliff edges, springs, Hans Flat ranger station, main access road, raptor nests, highly erodible soils, viewsheds, and critical overlooks. Each sensitive resource presented in table 4 is individually presented on figures 9-18. Additional standard protective restrictions are included in appendix C. Developable acreage would be reduced to 23,541 acres from the original 54,546 acres.

In addition to modifying the production scenario and applying protective restrictions, two major combinations of conversion and nonconversion within the proposed federal lease unit area are analyzed.

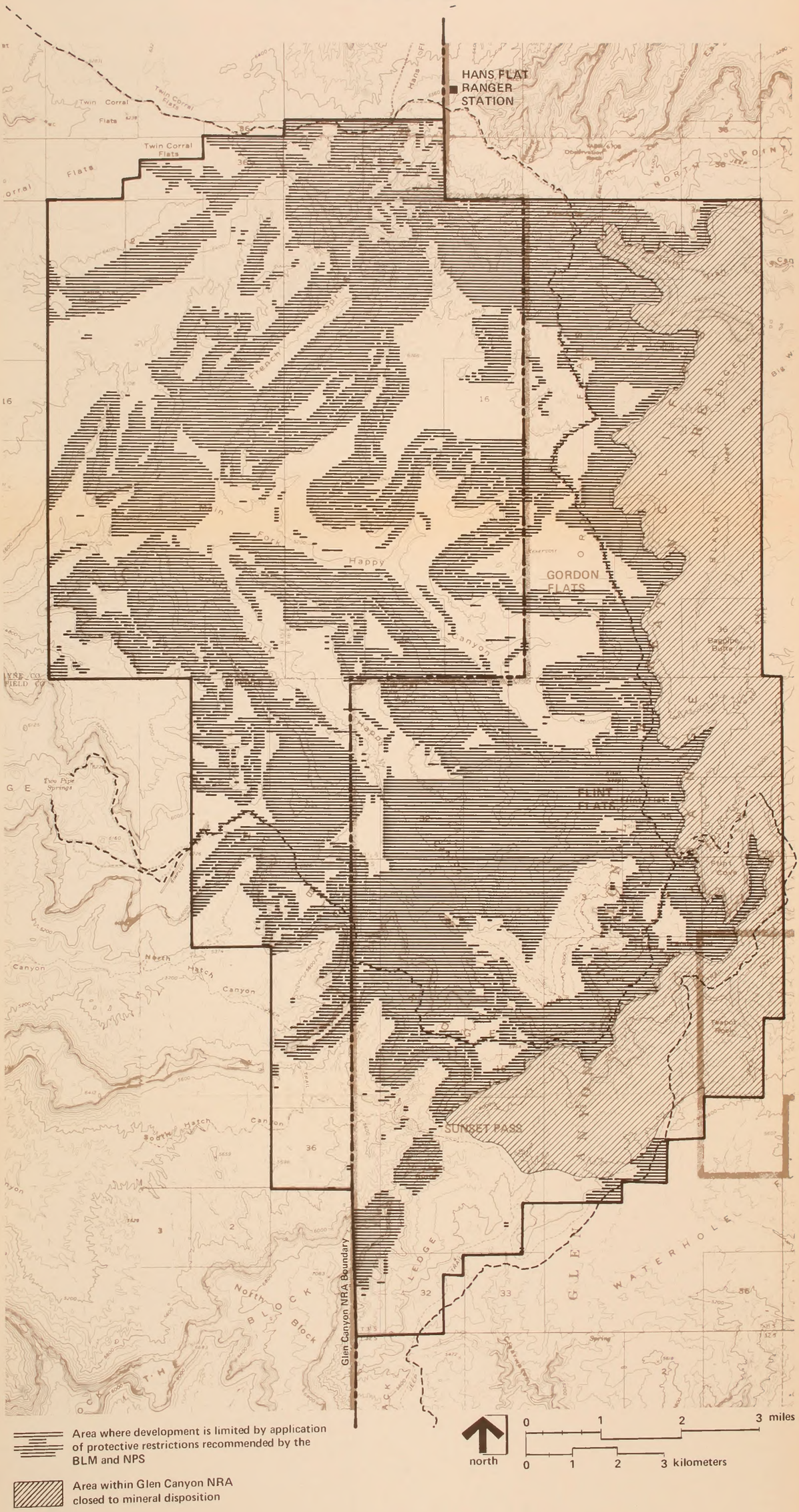


Fig. 8. Alternative 2A: Convert Leases With Additional Protective Restrictions

TST	40005
DSC	NOV 83

Table 3: Summary of Alternative 2A, 2B, and 2C Assumptions

Project Components	Development Phases I	II	III	IV
Number of wells	2 coreholes	up to 15 coreholes	8	minimum 308
Injection/production wells	NA	NA	2 inj/6 prod	141 inj/167 prod (min. per prospective area)
Miles of major new access (within lease unit)	none	12 (temporary access only)	none	27
Area disturbed for extraction processing, and ancillary facilities	2 acres	up to 15 acres	15-20 acres	up to 38,790 acres (265 acres at one time)
Peak workforce	7	7-10	57	390
Duration of project	15 days	75 days	2 years	not known
Production rate	NA	NA	up to 500 bpd	3,000-5,000 bpd (estimated)
Extraction type	NA	NA	in-situ steam-drive	in-situ steam-drive
Equipment	NA	NA	2 steam boilers	fluidized bed combustion units
Fuel source	diesel	diesel	fuel oil	coke
Water source	trucked in	trucked in	local wells	Dirty Devil River and local wells
Water requirement	NA	NA	94 acre-ft/yr	280 acre-ft/yr
Upgrading plant	NA	NA	offsite	delayed coking
Waste production	NA	NA	unknown	sulfur 15 short T/day solid 165 yd^3/day water 25 gpm
Product transport	NA	NA	truck	truck

Note: Phase IV project components are for each of the 18 prospective areas.

Table 4: Protective Restrictions for Sensitive Resources

Sensitive Resources	Criteria For Protection	Nature of Restriction	Acreage Affected				
			Alt 1	Alt 2A	Alt 2B	Alt 2C	Alt 3
No operations on slopes greater than 33%	Reducing erosion, ensure slope stability; safety	NSO*	NA	12,910	7,960	8,180	NA
No operation in areas eligible or listed on the National Register of Historic Places	Protecting significant archeological and historic resources pursuant to the National Historic Preservation Act of 1966 (as amended) and Executive Order 11593	NSO	NA	5,340	5,065	795	NA
500-ft setback from cliff edges	Protecting escape terrain for Bighorn sheep and raptor nesting habitat as recommended by USFWS, Utah Dept. of Wildlife and NPS management goals; reduce danger of rockfalls and fracturing of cliff faces during steam steam injection to protect public health and safety	NSO	NA	7,250	5,020	3,655	NA
one-half-mi buffer around springs, seeps, and wells	Protecting local recharge areas; minimize conflicts with wildlife and domestic animal use of water sources	NSO	NA	4,420	1,585	2,310	NA
1-mi radius buffer around development at Hans Flat	Reducing conflicts between operations and NPS visitor contact/residential areas as a public health and safety concern	NSO	NA	1,995	1,995	1,995	NA
Minimum 200-ft buffer on each side of centerline of Flint Trail Road	Reducing conflicts between visitors and operations to reduce public health and safety concerns; minimize visual impacts	NSO	NA	665	635	140	NA
No activities within 3,200-ft (1 km) radius buffer around active eagle and falcon nests	Protecting active nests during nesting season pursuant to Eagle Protection Act and NPS management goals	Seasonal NSO (mid-Feb - end of June)	NA	5,562	4,900	2,215	NA

No disturbance of soils classified as having very high wind erosion potential	Protection of soils; minimize soil loss and reduce erosion potential	NSO	NA	1,565	205	1,385	NA
No activities within Canyonlands National Park viewshed	Protection of Orange Cliffs as a scenic buffer to overlooks within Canyonlands National Park pursuant to P.L. 92-593 and supporting legislation; protection of visual aesthetics and recreation values	Limited NSO	NA	2,455	2,455	0	NA
No activities within one-half-mi buffer around critical overlook points along Orange Cliffs	Protection and management of key overlook locations of Canyonlands National Park pursuant to P.L. 92-593; minimize conflicts between recreationist and operations; maintenance of public access and enjoyment of overlooks; public safety; visual screening	NSO	NA	1,755	1,685	0	NA
Limit activities within critical viewsheds (visible from 3 or more stationary overlook points used by recreational visitors)	Reducing significant visual contrast from critical overlook locations; protection of scenic resource values pursuant to P.L. 92-593	Limited NSO	NA	1,965	795	1,575	NA
Nonimpairment standard for all WSAs[1]	No longterm or permanent occupancy/activities allowed within WSAs that could impair wilderness values	Nonimpairment of Wilderness Values		20,091	20,091	0	20,091	NA

Note: These are subject to adjustment after detailed study to determine the most appropriate distance or other restriction or verification of resource value.

* NSO is no surface occupancy. Seasonal NSO means that the restriction applies during times stated. Limited NSO means some activities could still be allowed within restricted zone if they are determined not to have an adverse affect on the sensitive resource under protection.

[1] The nonimpairment standard applies only until Congress acts. If Congress does not designate the WSA as wilderness, development could occur in these areas, subject to protective restrictions that would apply throughout the lease unit.

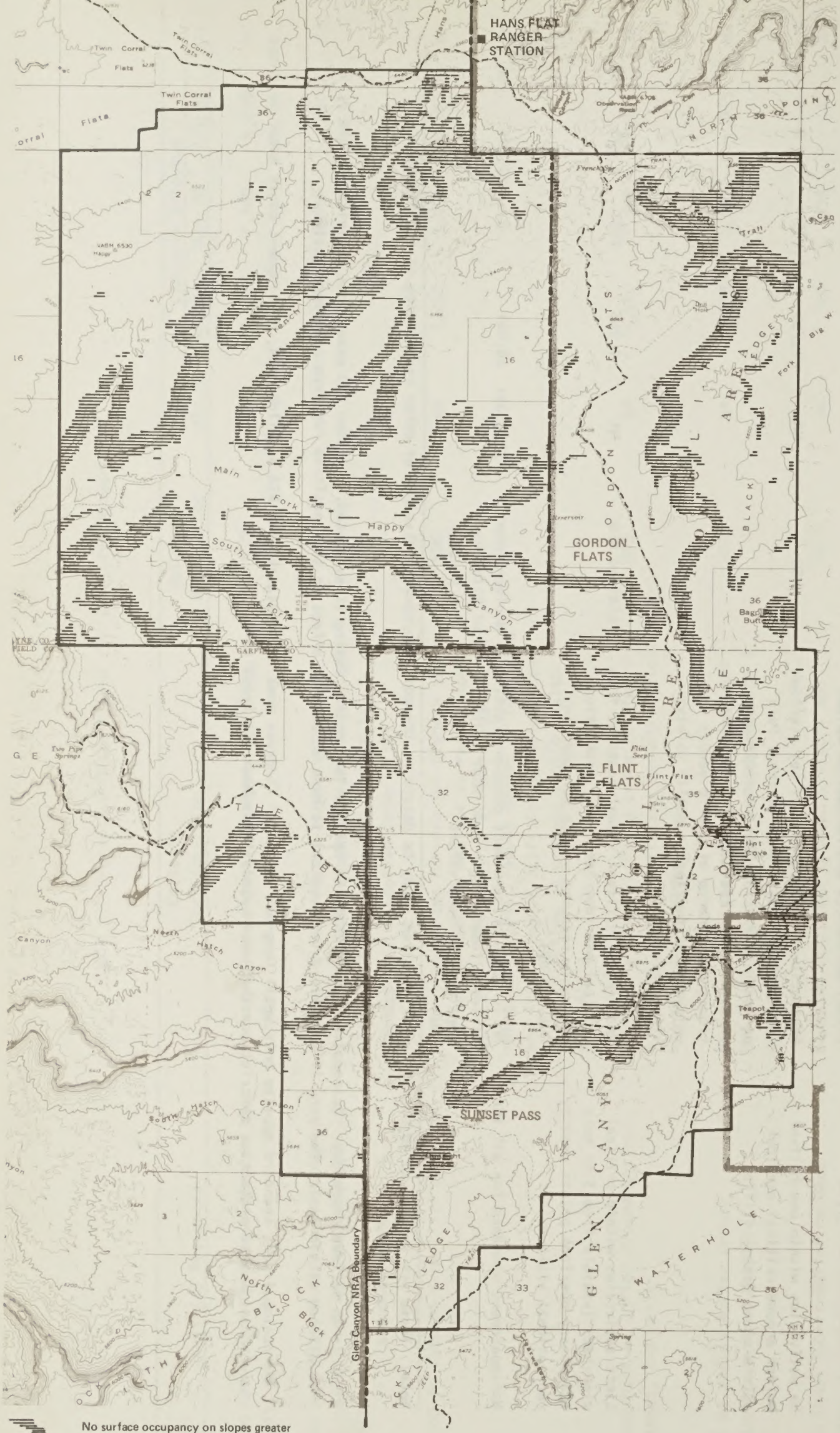


Fig. 9. Sensitive Resources—Steep Slopes

TST	40006
DSC	NOV 83

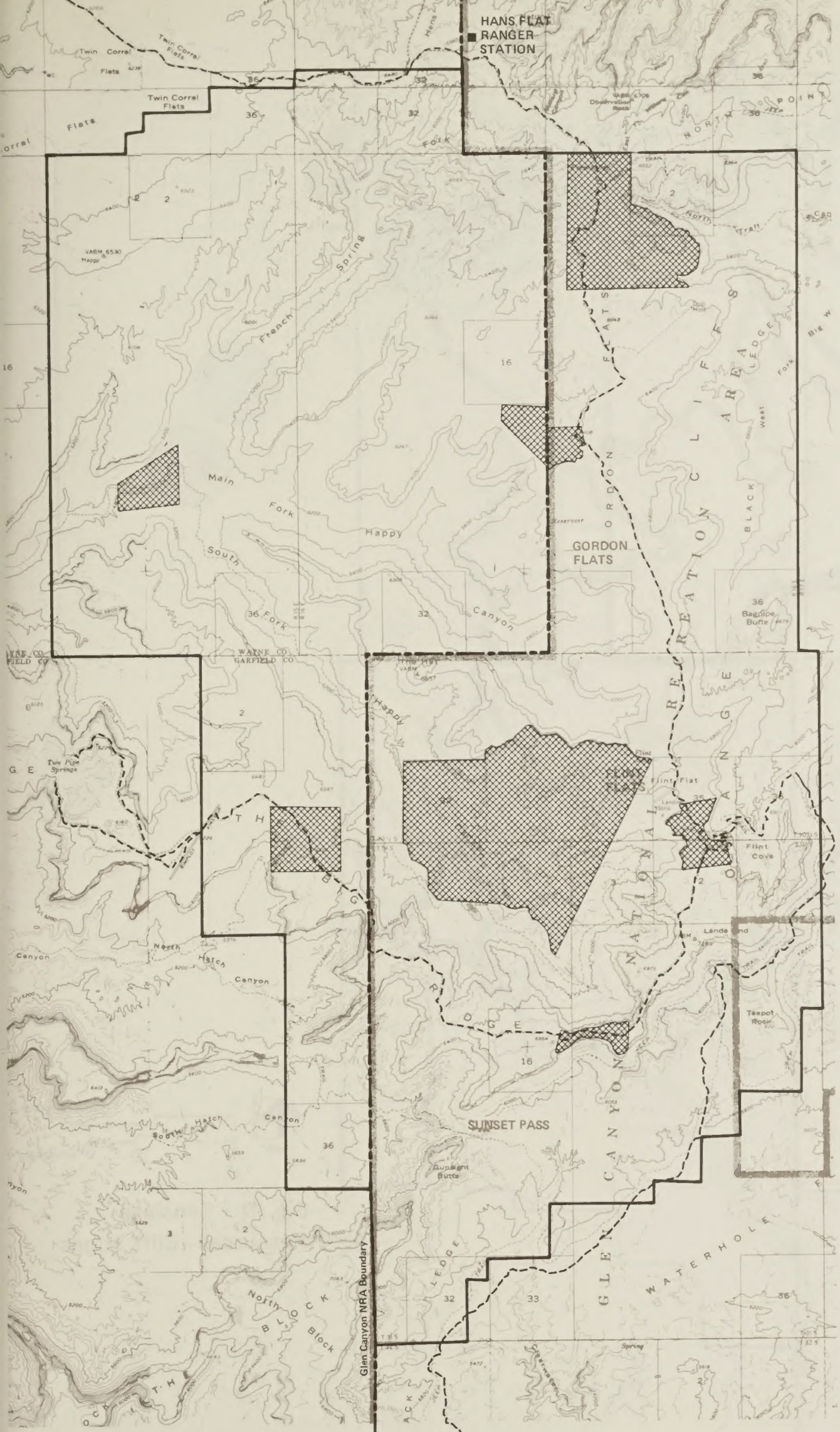


Fig. 10. Sensitive Resources—National Register Property

No surface occupancy within areas nominated to the National Register of Historic Places

TST	40007
DSC	NOV 83

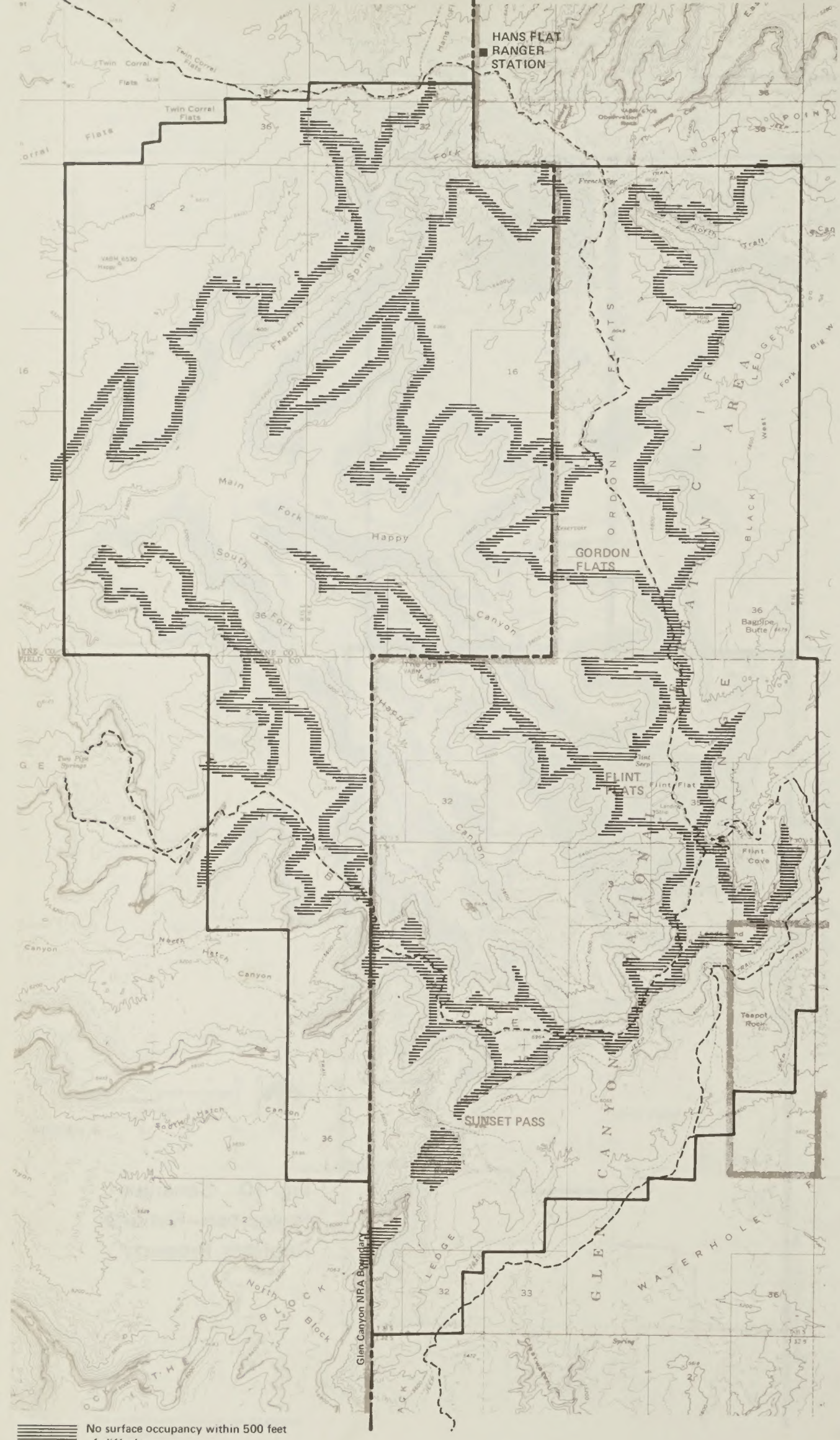
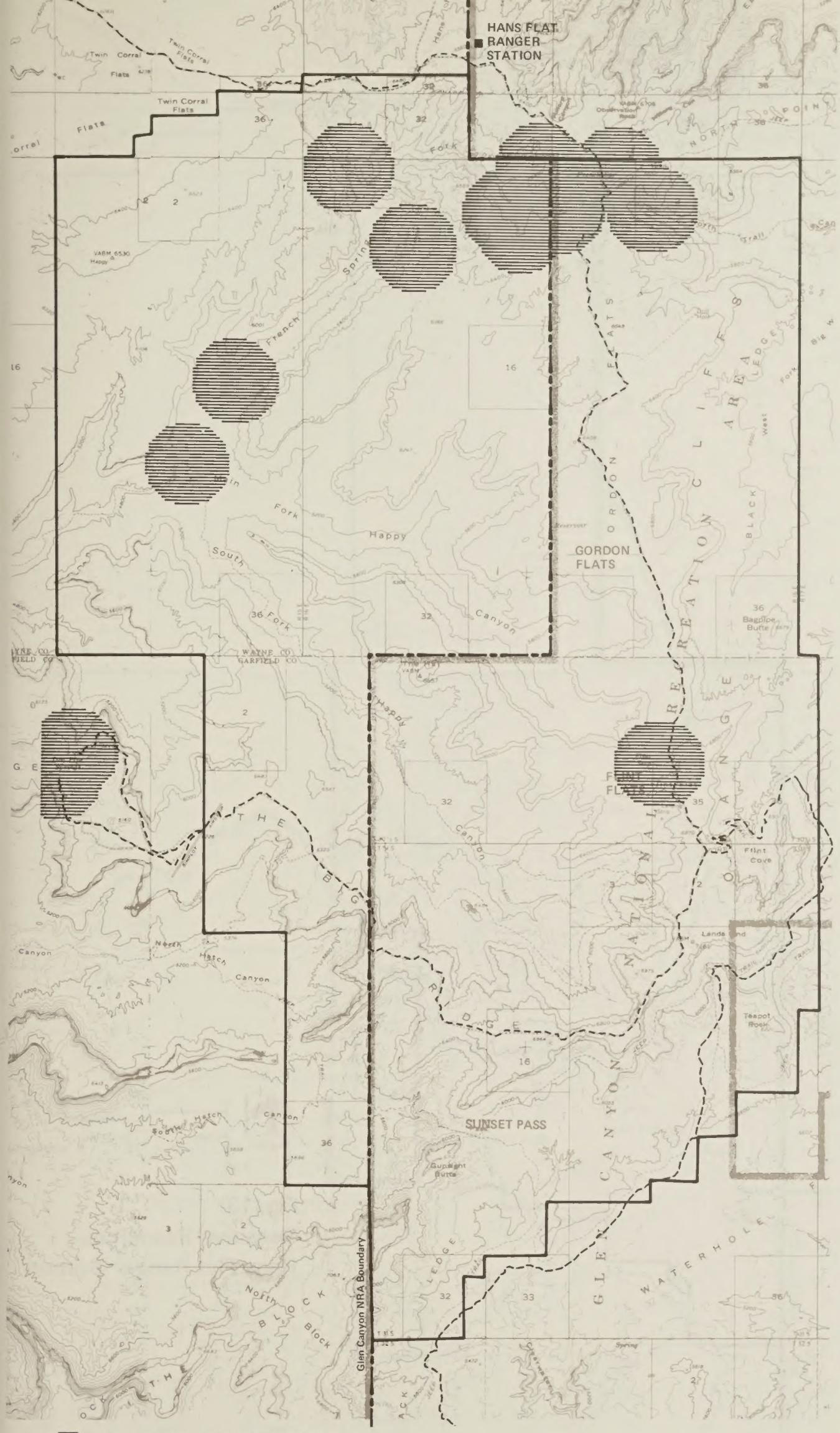


Fig. 11. Sensitive Resources—Cliff Edges

TST	40008
DSC	NOV 83



1/2 mile protective buffer around springs, seeps and water wells. No surface occupancy within this area.

Fig. 12.
Sensitive Resources-Springs, Seeps, and Wells

TST	40009
DSC	NOV 83

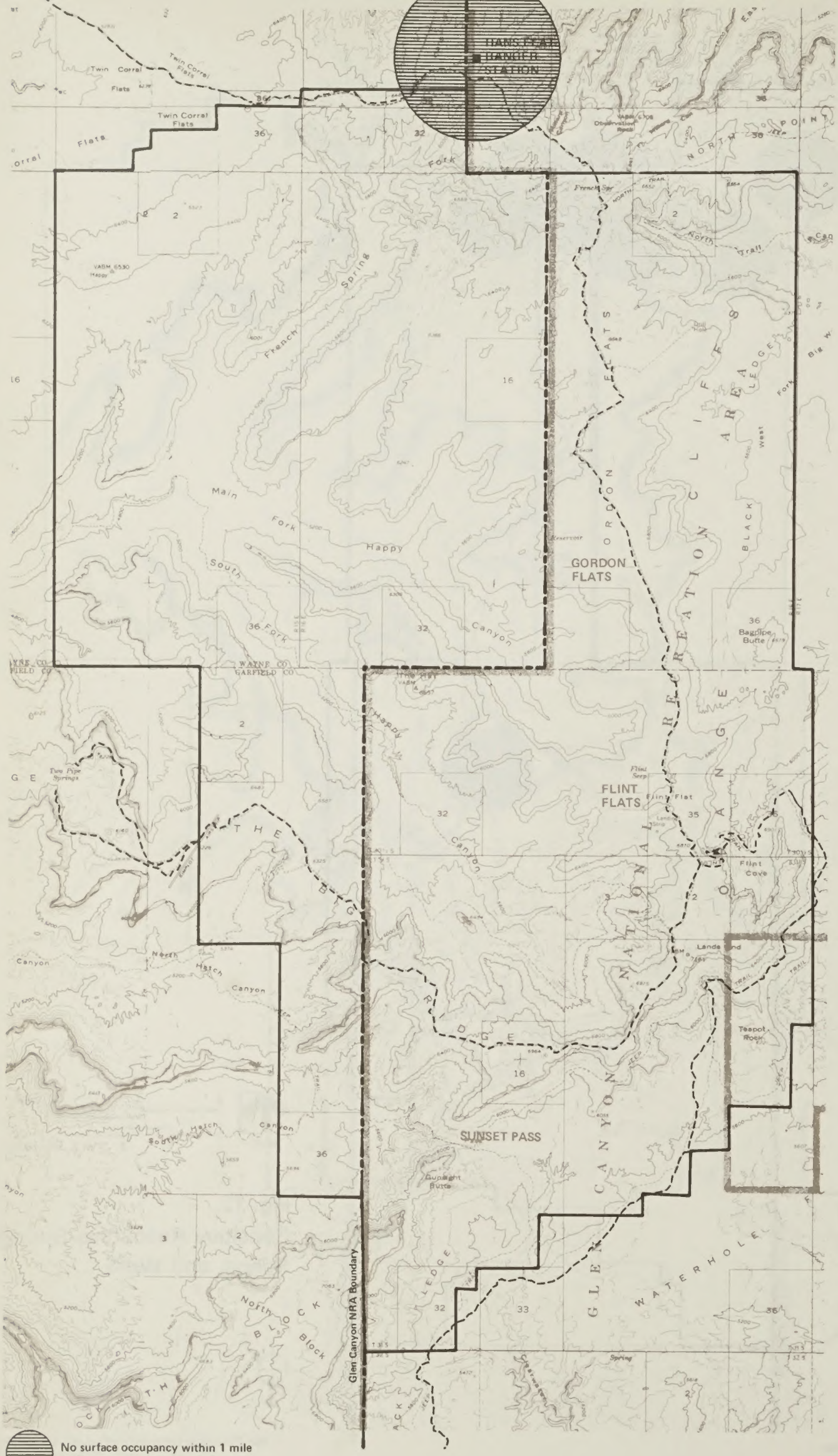


Fig. 13.
Sensitive Resources-
Hans Flat Ranger Station

TST	40010
DSC	NOV 8

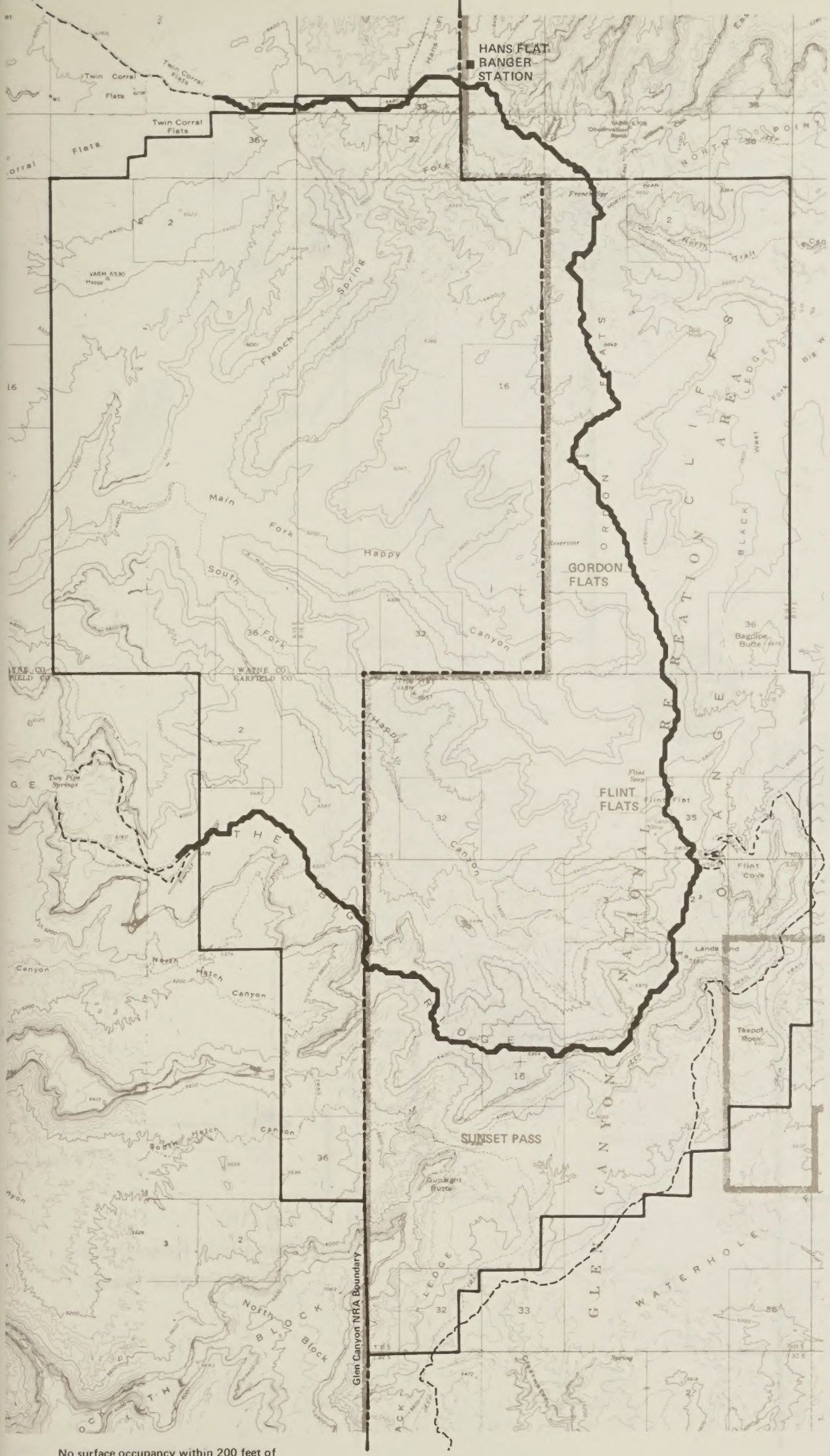
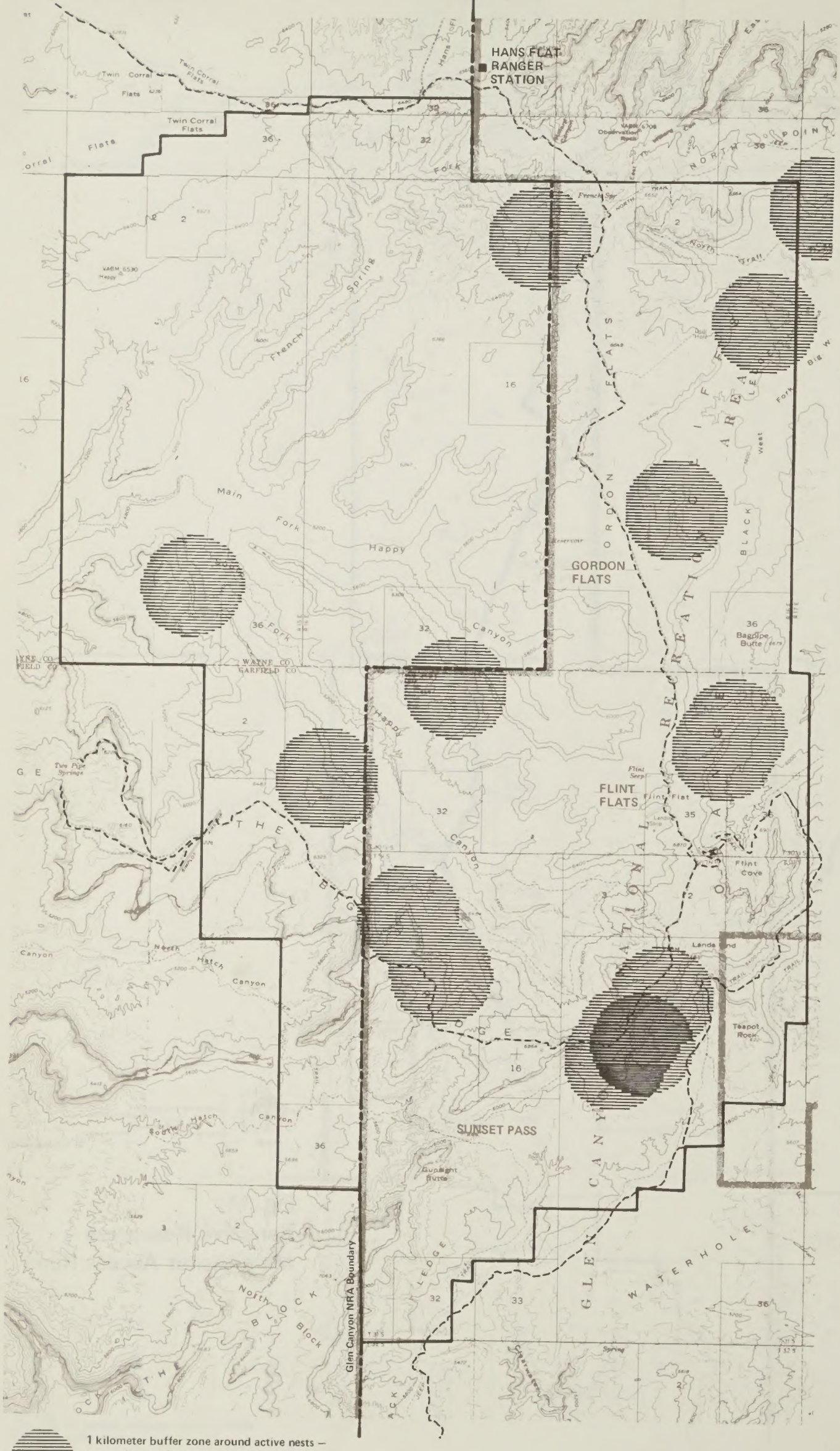


Fig. 14.
Sensitive Resources-
Main Visitor Access Road

No surface occupancy within 200 feet of the centerline of primary access road into national recreation area.

TST	40011
DSC	NOV 83



north

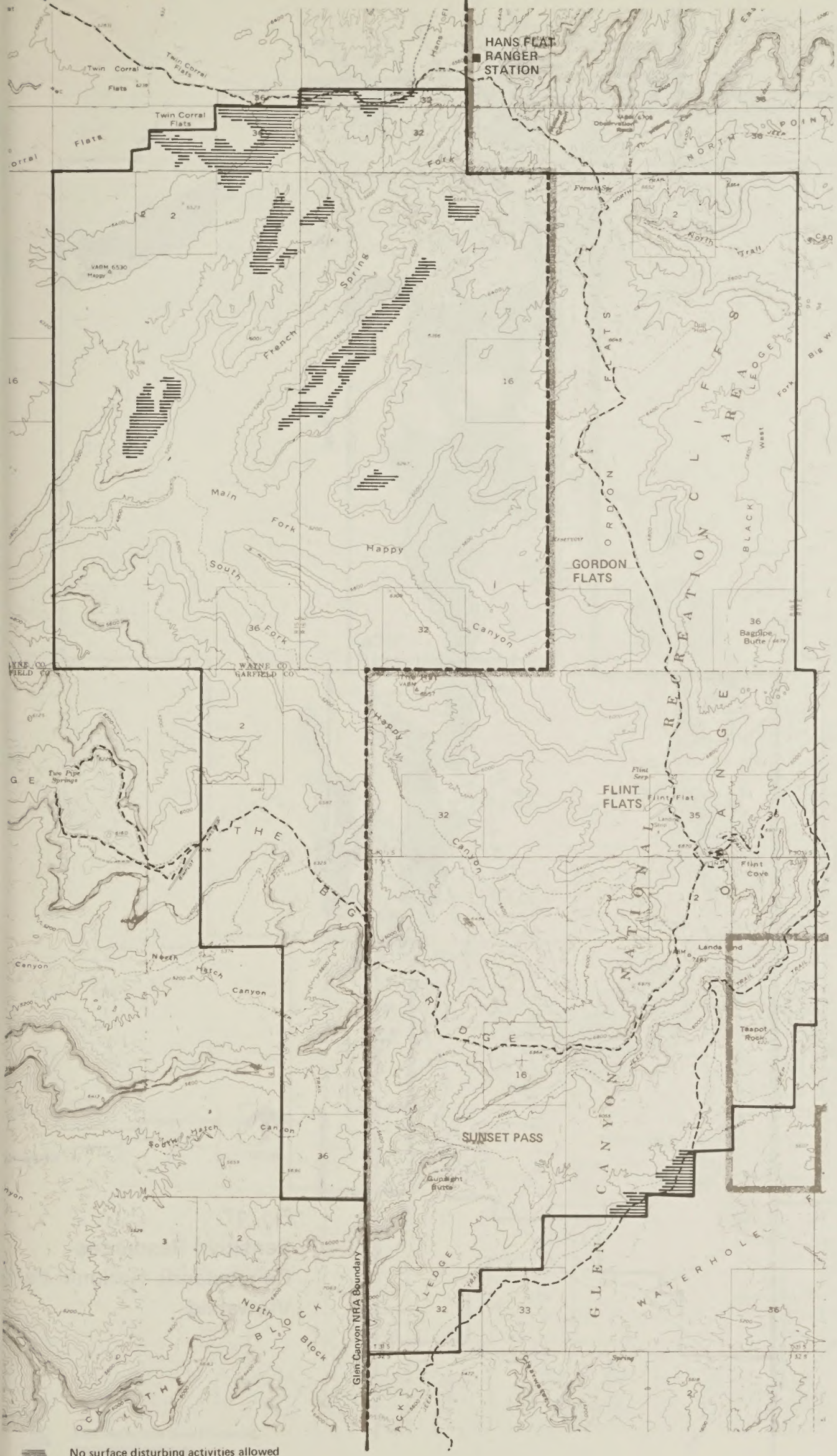
0 1 2 miles

0 1 2 3 kilometers

Fig. 15.
Sensitive Resources-
Active Raptor Nests

1 kilometer buffer zone around active nests – seasonal no surface occupancy (February-June) (subject to confirmation of nests at time operations are approved)

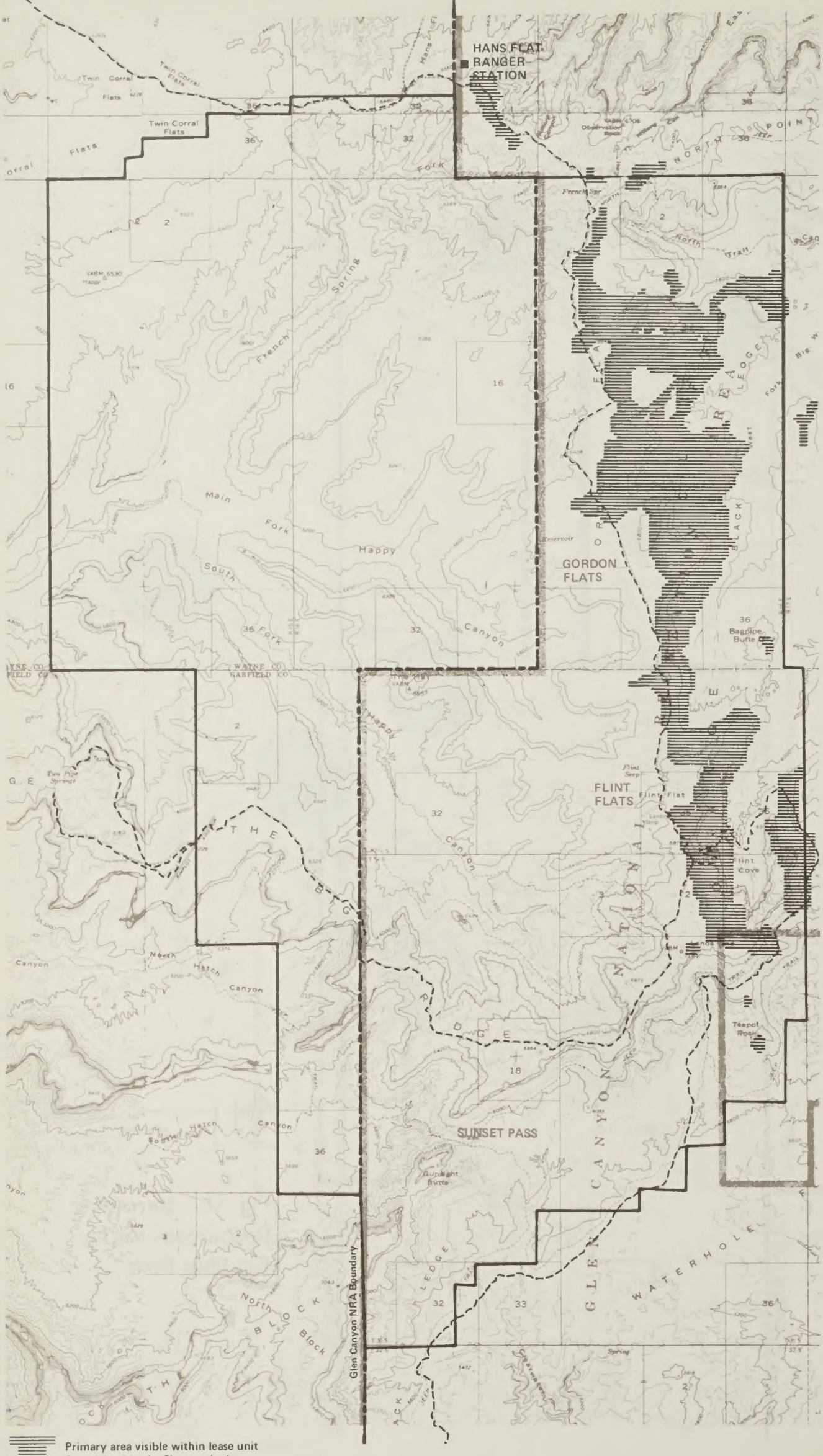
TST	40012
DSC	NOV 83



No surface disturbing activities allowed in these areas.

Fig. 16. Sensitive Resources—Highly Erodible Soils

TST	40013
DSC	NOV 83



Primary area visible within lease unit from Island in the Sky overlooks

Fig. 17.
Sensitive Resources-
Canyonlands National Park
Viewshed

TST	40014
DSC	NOV

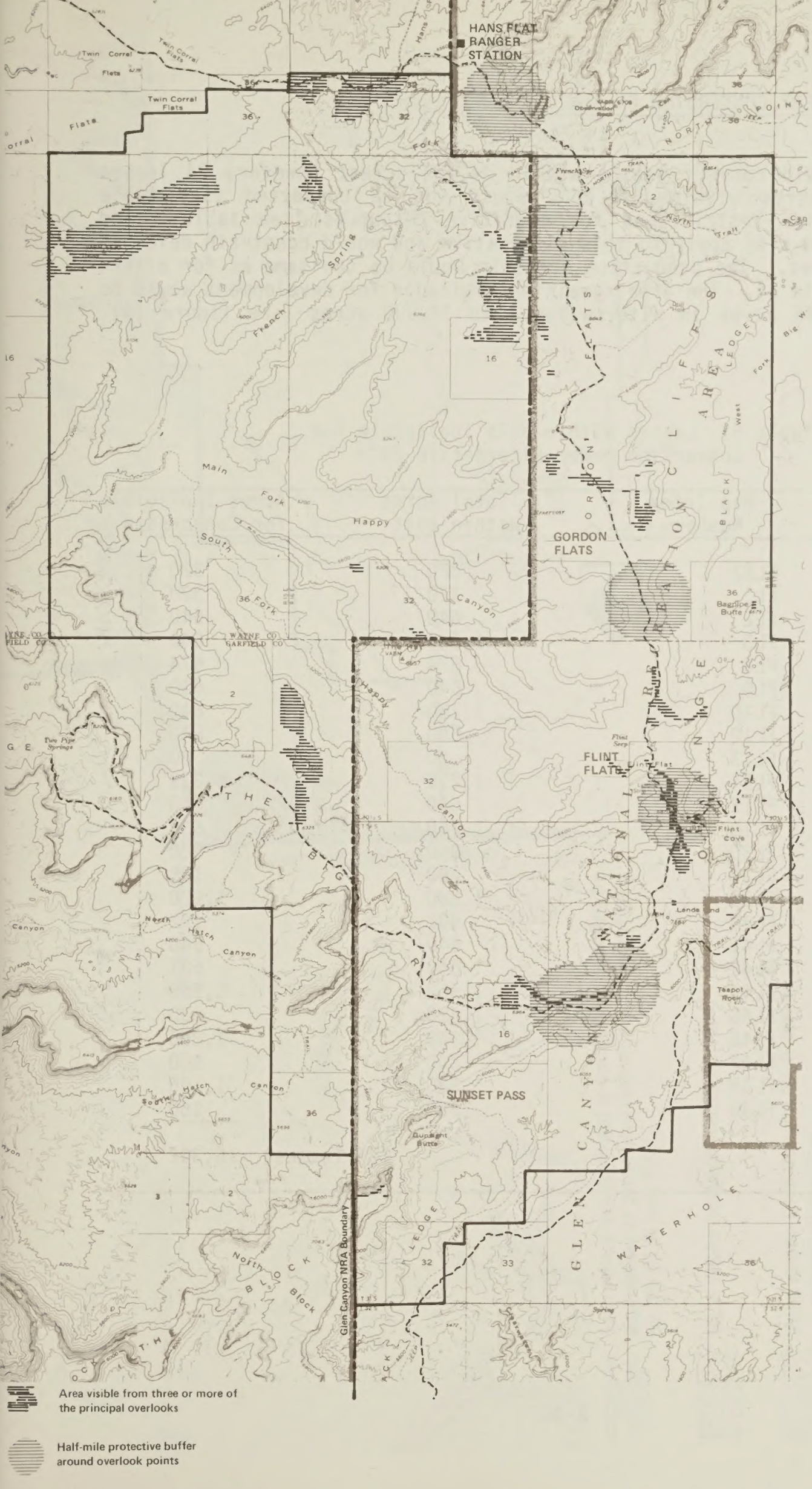


Fig. 18. Sensitive Resources—Critical Viewsheds from Orange Cliffs Overlooks

Area visible from three or more of the principal overlooks

Half-mile protective buffer around overlook points

TST	40015
DSC	NOV 83

ALTERNATIVE 2B: DENY CONVERSION ON BLM WSA LANDS

Alternative 2B would convert leases within 34,455 acres; however, 24 leases covering 16,302 acres within BLM WSAs would not be converted (see table 5). The protective restrictions for sensitive resources (see table 4 and figures 9-18) would also apply to this alternative and would constrain development on 20,365 acres. The production scenario would be the same as for alternative 2A (see table 3). The area remaining available for development would be reduced from 54,546 acres in alternative 1 to 14,090 acres (see figure 19).

Table 5: Leases Within WSAs Ineligible for Conversion Under Alternative 2B

Lease Number	Map Index Number	Total Acres Within Unit	Acres Ineligible for Conversion
U-0108406-A	FL51	320	320
U-934	FL1	320	320
U-2521	FL2	640	640
U-4444	FL3	1,280	640
U-4585	FL8	674	674
U-4659	FL9	640	640
U-5131	FL10	1,280	640
U-7648	FL12	640	640
U-8291	FL13	80	80
U-8291-A	FL14	1,279	1,279
U-17782	FL17	640	640
U-17782-A	FL18	1,760	638
U-20002	FL30	880	600
U-21084-A	FL37	480	138
U-21160	FL39	1,920	1,920
U-21241	FL40	481	192
U-21488	FL41	640	640
U-21488-A	FL42	640	621
U-21489	FL43	1,559	1,559
U-33409	FL45	1,420	30
U-34345	FL46	1,880	1,295
U-44334	FL47	800	800
U-44733	FL48	1,320	1,196
U-45845	FL49	360	160
Total		(24 leases)	16,302

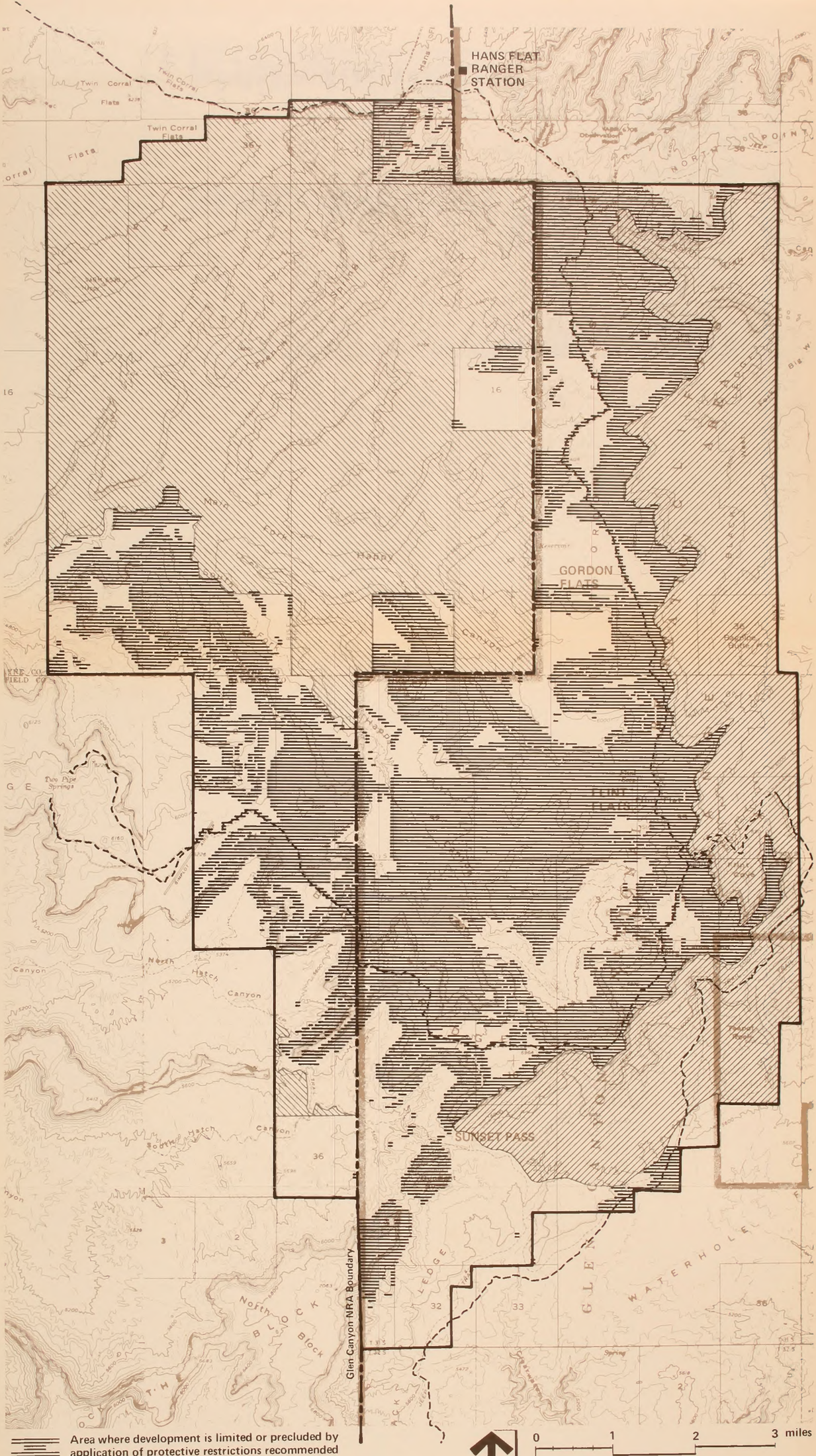


Fig. 19. Alternative 2B: Deny Conversion on WSA Lands

ALTERNATIVE 2C: DENY CONVERSION ON NPS NRA LANDS

Alternative 2C would convert leases within 31,210 acres; however, 23 leases covering 21,023 acres within Glen Canyon National Recreation Area would not be converted (see table 6). The same sensitive resource restrictions would also apply to this alternative (see table 4 and figures 9-18) and would constrain development on 16,465 acres. The nonimpairment management standard would be applied to lands within BLM WSAs. The production scenario would also be the same as for alternative 2A (see table 3). The area remaining for development would be reduced to 14,745 acres (see figure 20).

Table 6: Leases Within NRA Ineligible for Conversion Under Alternative 2C

Lease Number	Map Index Number	Total Acres Within Unit	Acres Ineligible for Conversion
U-5131	FL10	1,280	640
U-20002	FL30	880	280
U-20859-A	FL34	220	220
U-20859	FL33	2,060	2,060
U-17784	FL20	1,030	1,030
U-20292	FL31	1,200	1,200
U-18403	FL22	211	211
U-20860	FL35	1,285	1,285
U-18656	FL23	1,440	1,440
U-18658	FL25	1,920	1,920
U-18659	FL26	859	859
U-18657	FL24	1,480	1,480
U-18660	FL27	1,120	1,120
U-7167	FL11	598	598
U-2755	FL6	640	640
U-17782-A	FL18	1,760	1,120
U-20515	FL32	640	640
U-8291-F	FL15	40	40
U-17781	FL16	1,880	1,880
U-2754	FL5	1,080	1,080
U-17783	FL19	960	960
U-2756	FL7	160	160
U-8291-G	FL50	160	160
Total		(23 leases)	21,023

ALTERNATIVE 3: DENY CONVERSION OF ALL LEASES (NO ACTION)

The no-action alternative would deny conversion of all leases within the proposed federal lease unit. Leases not converted to combined hydrocarbon leases would remain as valid oil and gas leases until expiration of the original oil and gas lease term. Sporadic oil and gas exploration and development activities would continue. Such activities could occur on any of the unexpired oil and gas leases within the proposed federal lease unit.

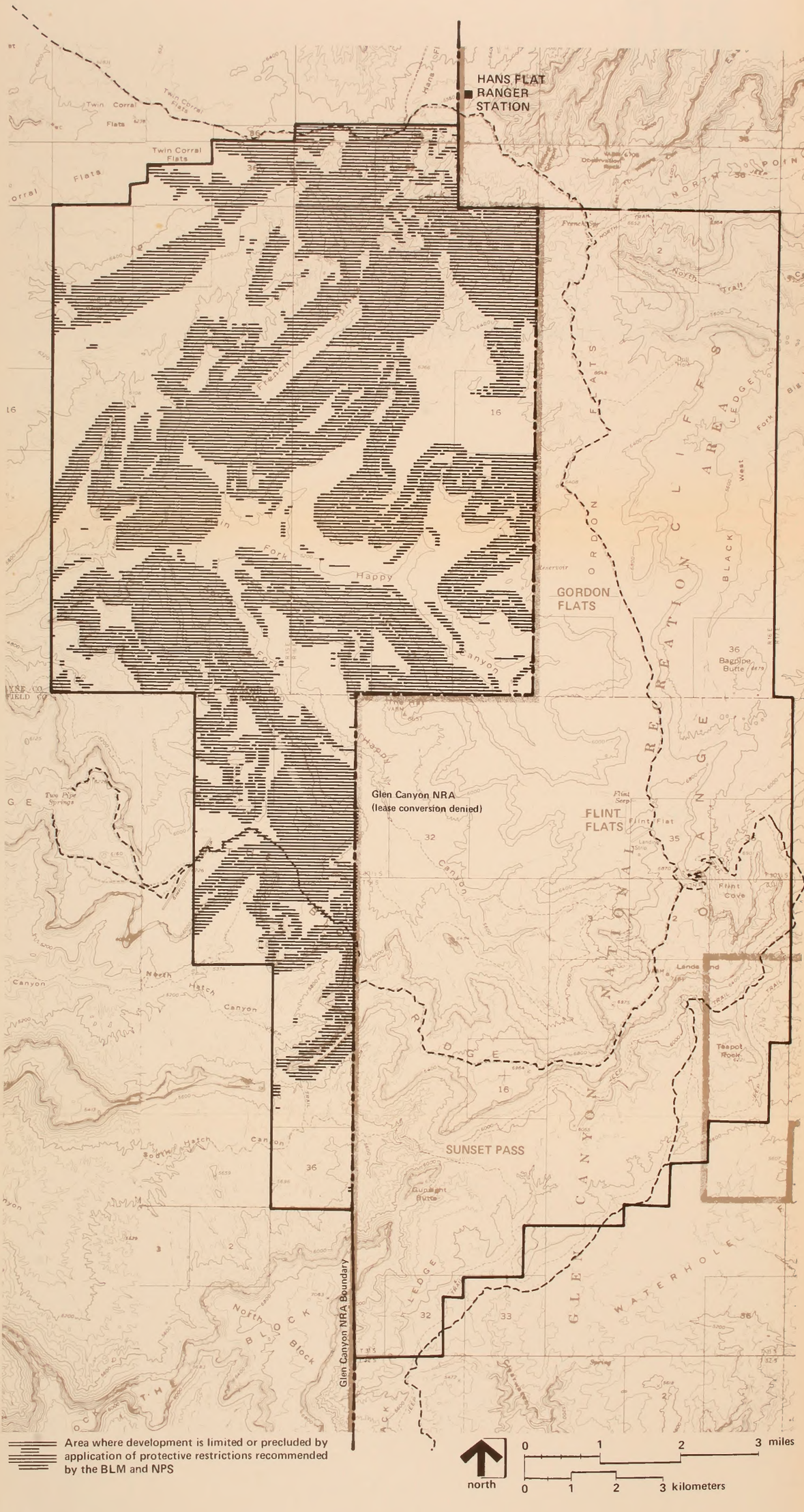


Fig. 20. Alternative 2C: Deny Conversion on NRA Lands

TST	40017
DSC	NOV 83

EVALUATION AND COMPARISON OF THE ALTERNATIVES

The acreages eligible for conversion, restricted for sensitive resource protection, and available for development under each of the five alternatives are presented in table 7. The four-phased proposed development for each alternative is also described.

The environmental consequences of the alternatives are evaluated and compared in table 8. These impacts are discussed in detail in the "Environmental Consequences" section.

Table 7: Comparison of Alternatives

Alternative	Applicants' Proposal				Eligible Conversion (acres)	Restricted For Resource Protection (acres)	Available for Normal Development (net acres)
	Phase I	Phase II	Phase III	Phase IV			
1 (proposed action)	As proposed by applicants	As proposed by applicants	As proposed by applicants	As proposed by applicants	54,546*	NA	54,546
2A (modified action)	No change	Some well locations moved or eliminated to protect sensitive resources	Wellfield and pilot plant moved slightly to protect sensitive resources; operation modified by protective restrictions	Nonimpairment standard enforced in WSAs; all proposed activity modified by protective restrictions; lowered production rate assumed to reduce impacts related to intensity of development	54,546	31,005	23,541
2B (deny conversion in WSAs)	No change	4 proposed well locations within WSAs relocated; others moved to protect sensitive resources	No activity allowed in WSAs; operation modified by protective restrictions	No activity allowed in WSAs; operation modified by protective restrictions lowered production rate assumed to reduce impacts related to intensity of development	34,455	20,365	14,090
2C (deny conversion in NRA)	Proposed location eliminated or relocated	8 proposed core locations in NRA relocated; others moved to protect sensitive resources	No activity allowed in NRA; phase III not possible at proposed location	No activity allowed in NRA: operation modified by protective restrictions; lowered production rate assumed to reduce impacts related to intensity of development	31,210	16,465	14,745
3 (no action - deny conversion of all leases)	NA	NA	NA	NA	NONE	NA	NONE

*The acreage figure shown is derived from the acreage of the applicant's proposed lease unit (66,040), minus the lands within that unit in Glen Canyon National Recreation Area closed to mineral disposition (11,494 acres).

Table 8: Comparison of Environmental Consequences of the Alternatives
(Development Phases I-IV)

	Alternative 1 Convert All Leases (Applicants' Proposal)	Alternative 2A Convert All Leases With Protective Restrictions	Alternative 2B Deny Conversion in WSAs	Alternative 2C Deny Conversion in NRA	Alternative 3 Deny Conversion of All Leases (No Action)
Geology	The extensive subsurface fracturing required (areal extent 38,790 acres) could change the chemical and physical rock characteristics and result in subsidence and rockfalls	Likelihood of rockfalls would be reduced by cliff setback requirement	Likelihood of rockfalls reduced by cliff setback requirement	Likelihood of rockfalls reduced by cliff setback requirement	Sporadic oil and gas activity would continue; subsidence and rockfalls would be unlikely
Topography	Construction activities (including road building, pipelines, steam generation and upgrading facilities) would alter topographic features on up to 54,546 acres within the extraction areas in increments of about 1,400 acres at any one time	Disturbance would occur on 23,541 acres in increments of about 265 acres at any one time	Disturbance would occur on 14,090 acres in increments of about 265 acres at any one time	Disturbance would occur on 14,457 acres in increments of about 265 acres at any one time	Continued oil and gas exploration and development would not require construction of analogous major industrial facilities; topographic disturbance would therefore be minimal
Paleontology	Direct effects are not expected to be significant; secondary effects (increased collection and vandalism) could occur due to increased numbers of people in the area	Direct effects not significant; secondary effects due to numbers of employees about one-sixth that of alternative 1; secondary effects due to increased visitation similar to alternative 1	Similar to alternative 2A	Similar to alternative 2A	Direct effects are not expected to be significant; secondary impacts would continue at historic levels
Energy and Minerals	30,000 bpd bitumen would be removed over an indefinite time period, reducing the amount of reserves available; recovery of uranium resources from the same areas would be reduced or precluded	5,000 bpd bitumen would be removed over an indefinite time period, reducing the amount of remaining reserves available; recovery of uranium resources from the same areas would be reduced or precluded	Similar to alternative 2A	Similar to alternative 2A	The bitumen resource would remain in place and available for future competitive leasing; conflicts between oil and gas activity and uranium resource recovery would be minimal

	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Water Resources	Annual processing and extraction water use would be 1,679 acre-feet (from the Dirty Devil River), 2.0 to 2.7 tons of silt per acre-foot would be disposed of onsite; steam injection and surface operations could disrupt aquifers and recharge areas and may reduce quantity and quality of flows in springs, seeps, and wells; availability of groundwater for future uses could be reduced	Annual processing and water use would be 280 acre-feet (from the Dirty Devil River); 2.0 to 2.7 tons of silt per acre-foot would be disposed of onsite; impacts on springs, seeps, and wells would be reduced by one-half-mile setback from water sources	Similar to alternative 2A	Similar to alternative 2A	Water use requirements would be minimal for oil and gas activity; because high pressure steam injection would not be done, major aquifer disruption is not anticipated
Soils	Approximately 29,882 acres would be disturbed during the life of the project; 50 million cubic yards of soils would be moved; cryptogamic soil crusts would be destroyed	Approximately 13,100 acres of soils would be disturbed during the life of the project; 21 million cubic yards of soils would be moved; slopes in excess of 33 percent and high erosion hazard soils would be avoided	Approximately 7,447 acres of soils would be disturbed during the life of the project; 12 million cubic yards of soils would be moved; slopes in excess of 33 percent and high erosion hazard soils would be avoided	Approximately 7,523 acres of soils would be disturbed during the life of the project; 12 million cubic yards of soils would be moved; slopes in excess of 33 percent and high erosion hazard soils would be avoided	No significant impacts anticipated
Vegetation	Approximately 14,335 acres of vegetation would be cleared over the life of the project; reclamation would be slow and difficult due to arid environment and intensive measures would be required; no threatened or endangered species would be affected	Approximately 5,902 acres of vegetation would be lost over the life of the project; reclamation would require intensive measures to be successful; no known threatened or endangered species would be affected	Approximately 3,582 acres would be removed over the life of the project; however, no more than 265 acres would be disturbed at any one time; reclamation would require intensive measures to be successful; no known threattened or endangered plant species would be affected	Approximately 3,435 acres would be totally removed over the life of the project; however, no more than 265 acres would be disturbed at any one time; reclamation would require intensive measures to be successful; no known threattened or endangered species would be affected	No significant impacts anticipated

	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Wildlife	Up to 54,546 acres of wildlife habitat would be disturbed over a 160 year period; up to 1,400 acres would be actively disturbed at any one time; adverse impacts on all wildlife from increased human activity, noise, and other disturbance; reintroduction of bighorn sheep into the area may be slowed or halted; raptor habitats would be disturbed or project operation modified for up to four months per year	Up to 23,541 acres of wildlife habitat could be disturbed over a period exceeding 160 years; up to 265 acres would be disturbed at one time; bighorn reintroduction may be slowed or halted	Similar to alternative 2A except that the intensity of the impacts would be reduced in the WSAs	Similar to alternative 2A, except that the intensity of the impacts would be reduced in the NRA and Canyonlands	Impacts significantly above existing levels not anticipated
Air Quality	For 4% sulfur bitumen, the 3-hour class II SO_2 PSD increment would be exceeded by a factor of 1.54, the 24-hour increment by a factor of 5.83, and the NAAQS for SO_2 would be exceeded by 1.49; short-term class II particulates PSD increment would be exceeded by a factor of 8.28, the annual by 7.42, the 24-hour NAAQS for particulates would be exceeded by 1.52, and the annual by 2.12; maximum concentration levels would occur in Glen Canyon; for 4% sulfur bitumen, short-term and annual class I SO_2 PSD increments would be exceeded in Canyonlands and the 24-hour SO_2 increment would be exceeded in Arches NP; adverse effects on visibility expected in Canyonlands	For 4% sulfur bitumen, the short-term class II SO_2 PSD increment would be exceeded by a factor of 1.38 in Glen Canyon; the short-term class I SO_2 PSD increment would be exceeded by a factor of 1.3 in Canyonlands; adverse impacts on visibility would be moderate, but depending upon the exact location and configuration of the upgrading plant, could still be of concern; adjustments in plant design could enable this alternative to meet air quality standards at a production level in the range of 2,800-5,000 bpd	Similar to alternative 2A	Similar to alternative 2A	Changes in existing air quality are not expected

	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Noise	Noise levels at the Gordon Flats site would be high enough to cause hearing impairment within 600 feet of edge of site; adverse nonauditory effects (stress, annoyance, sleep loss, etc) would occur at and adjoining to development areas 24 hours per day for the 160 year life of the commercial development phase	Noise levels high enough to cause adverse auditory effects offsite are not anticipated; noise levels significantly above maximum background levels would occur within a 2-mile radius of site; adverse nonauditory effects would be reduced	Similar to alternative 2A, but areas within WSAs would have the benefit of additional attenuation distance, so adverse nonauditory effects would be reduced	Similar to alternative 2A, but areas within Canyonlands and eastern portions of Glen Canyon would have the benefit of additional attenuation distance so adverse nonauditory effects would be reduced	Noise levels significantly above existing levels not anticipated
Scenic Quality	Existing high-quality scenic values within the operating area would be lost; value of the Orange Cliffs as a scenic buffer to Canyonlands would be seriously diminished; much of the operation would be visible from Canyonlands; BLM's VRM management class restrictions would be exceeded for 19,000 acres of the project area	Scenic setbacks applied; scenic resource impacts in Canyonlands minimized; overall impact on the rest of the area reduced (but not eliminated) by applying mitigation measures; VRM standards would still be exceeded on 8.946 acres of BLM land; scenic qualities adversely affected in Glen Canyon	Similar to alternative 2A, except if WSAs are not converted, construction of major upgrading facilities in Glen Canyon is more likely, resulting in an increase in scenic resource conflicts in Glen Canyon and Canyonlands; VRM standards exceeded on 2,891 acres of BLM land; scenic qualities adversely affected in Glen Canyon	Similar to alternative 2A, except that nonconversion within Glen Canyon would minimize (but not eliminate scenic resource conflicts in Glen Canyon and Canyonlands; VRM standards exceeded on 8,946 acres	Impacts above existing levels not anticipated
Cultural Resources	Major adverse effects on archeological sites throughout the unit through surface disturbance, unauthorized collecting and loss of in-context data; a minimum of 2,000 archeological sites in the unit could be affected; secondary impacts on the archeological resources of Canyonlands, including Horseshoe Canyon, from the increased numbers of people in the area	Limitations on surface disturbance would reduce direct impacts; a minimum of 885 sites could be disturbed; secondary effects due to numbers of employees about one-sixth that of alternative 1; secondary effects due to increased visitation similar to alternative 1	Similar to alternative 2A; direct impacts on archeological resources in the WSA would be prevented; a minimum of 530 sites could be disturbed	Similar to alternative 2A; direct impacts on archeological resources in the NRA would be minimal; a minimum of 545 sites could be disturbed	Impacts above existing levels not anticipated

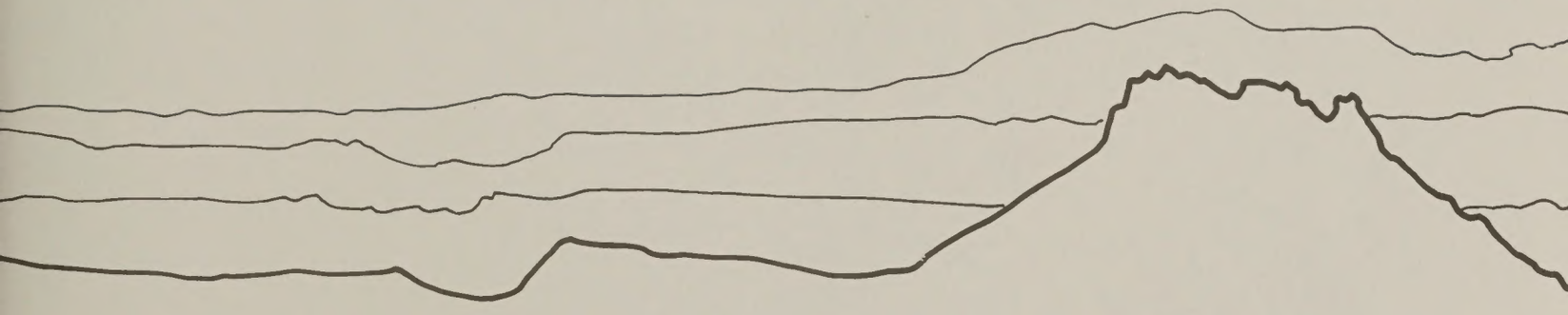
	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Socio-economics	Local communities would experience a large influx of workers (2,400 workers in 1994); major shortages would occur in housing, education, law enforcement, fire protection, health care, and public utility sectors; effects could recur up to 18 times as each new prospective area is brought on line; travel on several highways and roads in the area would exceed capacity resulting in road deterioration and higher operating costs; personal annual income for local residents associated with the project would increase; localized inflation may occur	Local communities would experience an influx of workers with a peak year workforce of 390 in 1994; shortages would occur in housing, public utilities, education, and fire protection; travel on a portion of UT 24 would exceed capacity; effects could recur up to 18 times as each new prospective area is brought on line; personal annual income for residents associated with the project would increase; localized inflation may occur	Local communities would experience an influx of workers with a peak workforce of 390 in 1994; shortages would occur in housing, public utilities, education, and fire protection; travel on a portion of UT 24 would exceed capacity; effects would recur up to 13 times as each new prospective area is brought on line; personal annual income associated with the project would increase; localized inflation may occur	Local communities would experience an influx of workers with a peak workforce of 390 in 1994; shortages would occur in housing, public utilities, education, and fire protection; travel on a portion of UT 24 would exceed capacity; effects would recur up to 8 times as each new prospective area is brought on line; personal annual income for residents associated with the project would increase; localized inflation may occur	Impacts above existing levels not anticipated
Recreation	Approximately 3,500 visitors per year seeking primitive and unconfined recreation would experience a degradation of the recreational experience in 23,336 acres of Glen Canyon and in adjacent portions of Canyonlands; visitation to Hans Flat could increase by about 950% due to access upgrading, shifting the recreational experience from primitive to developed, in conflict with NPS objectives of maintaining the primitive and unconfined recreational experiences in Glen Canyon and preservation of resources in Canyonlands	Similar to alternative 1, but direct land disturbance would be reduced to 23,541 acres; conflicts with recreation use in Glen Canyon and Canyonlands	Similar to alternative 2A, but direct disturbance of WSA lands would be eliminated; 14,090 acres of Glen Canyon and other BLM lands would be disturbed; conflicts with recreation use of BLM land would be reduced	Similar to alternative 2A, but NRA lands would not be disturbed for operational activities; 14,745 acres would occur all on BLM lands; conflicts with recreational use in Glen Canyon and Canyonlands would be reduced	Minor impacts (consistent with existing levels) on recreation could occur, but could be minimized by careful siting of oil and gas operations and restrictions on use of access routes

	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Wilderness	Portions of 455,330 acres of potential wilderness (9 areas) could be adversely affected by noise, sight, and odor intrusions, particularly in portions of four potential WSAs adjacent to project components; direct disturbance of 15 acres, in three BLM WSAs considered nonimpairing to wilderness values would be allowed under phases I and II; phases III and IV activities probably precluded in WSAs by nonimpairment standard	Similar to alternative 1	Similar to alternative 1, but no direct disturbance would occur in WSAs	Similar to alternative 1	Impacts above existing levels not anticipated

AGENCY PREFERRED ALTERNATIVE

This DEIS involves combined hydrocarbon lease conversions in the Tar Sand Triangle, Utah, and includes lands under the jurisdiction of the NPS (within Glen Canyon National Recreation Area) and the BLM. The requirement of identifying a preferred alternative in this DEIS has been waived (per memorandum of the Department of the Interior, Office of Environmental Project Review, dated October 12, 1983). The bureaus will identify their preferred alternative in the final EIS.

AFFECTED ENVIRONMENT



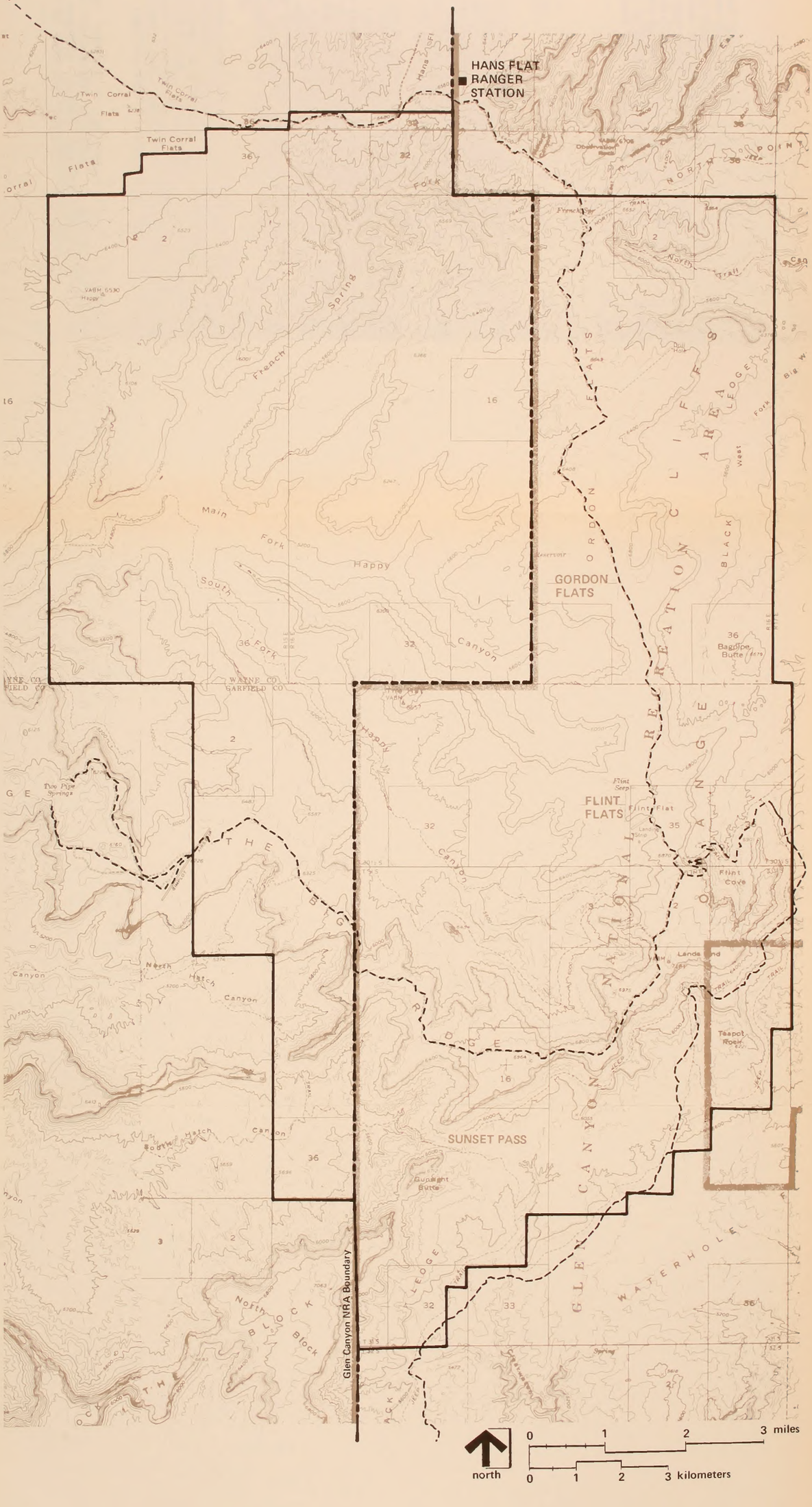


Fig. 21. Area Topography

TST	40018
DSC	NOV 83

NATURAL ENVIRONMENT

The proposed federal lease unit is located in the Colorado Plateau country of southeastern Utah, in a remote and rugged area of flat-topped mesas, vertical cliffs, and deeply incised canyons. The lease unit lies north and west of the Colorado River between the Dirty Devil River on the west and the Green River on the east atop the Orange Cliffs and includes Gordon Flats; Big Ridge; French Spring, Main, and South forks of Happy Canyon; Flint Flat; Gunsight Butte; and the southern portion of Twin Corral Flat (see figure 21). The proposed federal lease unit is partially within Glen Canyon National Recreation Area. Canyonlands National Park lies 3 to 6 miles to the east of the unit boundary.

GEOLOGY

Stratigraphy

The proposed federal lease unit is in the Paradox Basin of east-central Utah along the northern end of the Monument uplift. To the northeast of the site is the Salt anticline region and to the northwest is the San Rafael swell. The area contains Paleozoic and Mesozoic sedimentary rocks that dip gently to the northwest. Important stratigraphic units in the lease unit are, in descending stratigraphic order, the Glen Canyon group, the Chinle formation, the Moenkopi formation, and the Cutler group.

The Glen Canyon group is comprised of the Wingate sandstone, the Kayenta formation, and the Navajo sandstone. The Wingate sandstone--a massive 300-foot-thick sandstone--forms reddish-brown cliffs in the proposed federal lease unit. The Kayenta formation, which overlies the Wingate sandstone, is a buff brown, coarse sandstone with minor shale and limestone interbeds. The Navajo sandstone overlies the Kayenta formation and is characterized by large-scale, tangential cross-bedding. The lamination of the foreset beds is generally perfectly preserved, even down to a fraction of an inch in thickness. The maximum dip of individual laminae is 25 degrees at the top, and they may be up to 100 feet long before tangentially disappearing into the basal unit. The sand is medium to fine grained and is dominantly yellowish-white, pale buff to buffy brown.

The Chinle formation (below the Glen Canyon group) unconformably overlies the Moenkopi formation. The basal part is variegated bentonitic claystone, clayey siltstone, clayey sandstone, and thin widespread sandstone and conglomerates (also named Shinarump, Monitor Butte, and Moss Back members). The upper part of the Chinle formation consists of reddish, horizontally bedded or structureless siltstones, minor amounts of limestones, ripple-laminated siltstone and sandstone, limestone pebble conglomerate, and cross-bedded sandstones (USDI, GS 1972a).

The Moenkopi formation is composed of chocolate brown and red brown mudstones, shales, and argillaceous sandstones. Evidence suggesting a continental origin for this formation includes raindrop imprints, fossilized mud cracks, salt casts, and the color and character of the sediments.

The Cutler group, host for the tar sand deposit, lies stratigraphically below the Moenkopi formation and was derived from the late Pennsylvanian to early Permian Uncompahgre uplift, east of the proposed federal lease unit. Facies changes transform the coarse, clastic sediments of the undifferentiated Cutler group east of the lease unit into five distinct, complex stratigraphic units (see figure 22). The basal Cutler group interfingers northwestward with the Elephant Canyon formation of Wolfcampian age. A red bed interval interfingers westward with the Cedar Mesa sandstone in the center of the Cutler group. The Organ Rock shale separates the Cedar Mesa sandstone from the White Rim sandstone. The fifth stratigraphic unit of the Cutler group is a fine-grained red bed, distinguished from the overlying Moenkopi formation by the presence of a local angular unconformity.

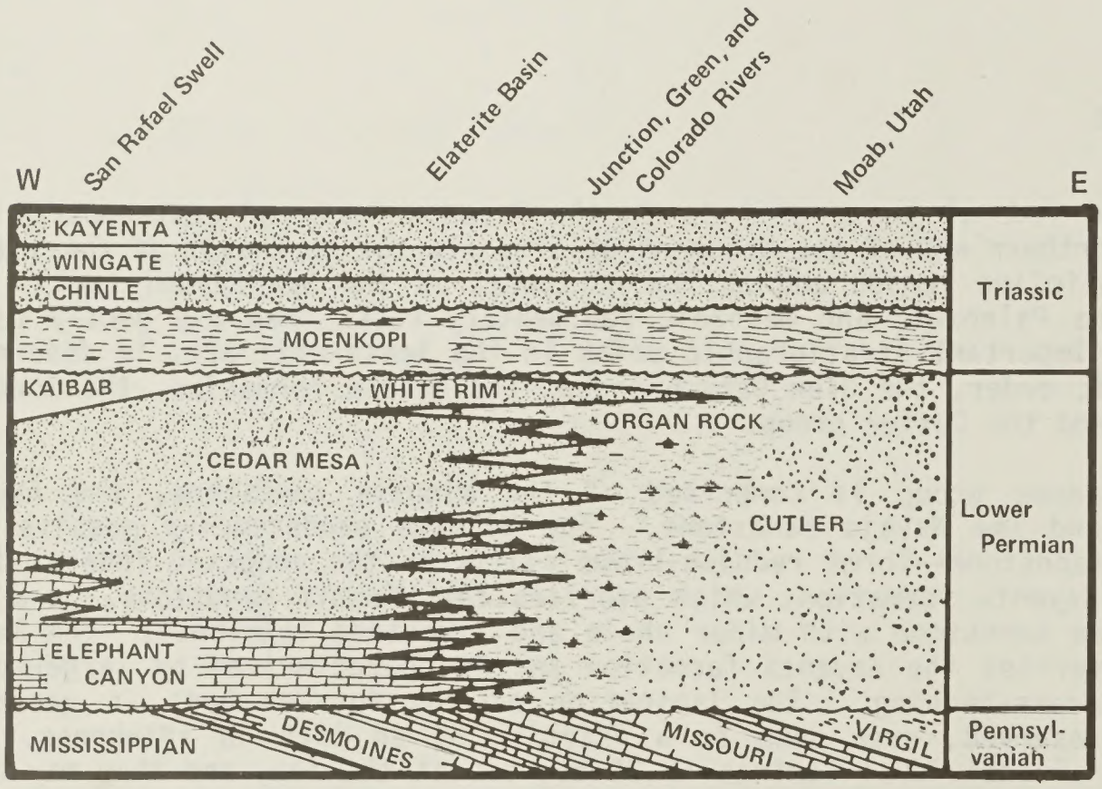


Fig. 22. Rock Units

The hydrocarbon (tar sand) deposit occurs in the White Rim sandstone in the upper part of the Permian aged Cutler group. The White Rim sandstone is composed of fine quartz grains well-sorted and subangular to subrounded. The sandstone also contains scattered grains or laminae of medium to coarse grained, well-rounded, and frosted quartz. The unit is poorly cemented and very friable. At the eastern margin of the proposed lease unit, the White Rim sandstone changes facies abruptly to a brown siltstone, similar to the Organ Rock shale.

Four lines of evidence observed in a detailed stratigraphic study of the White Rim sandstone in the lease unit area suggest that the White Rim is probably a nearshore, shallow water marine sandstone (Baars and Seager 1970). Evidence for this hypothesis includes the geometric configuration of internal sandbars, the types of cross stratification, and rippled surfaces.

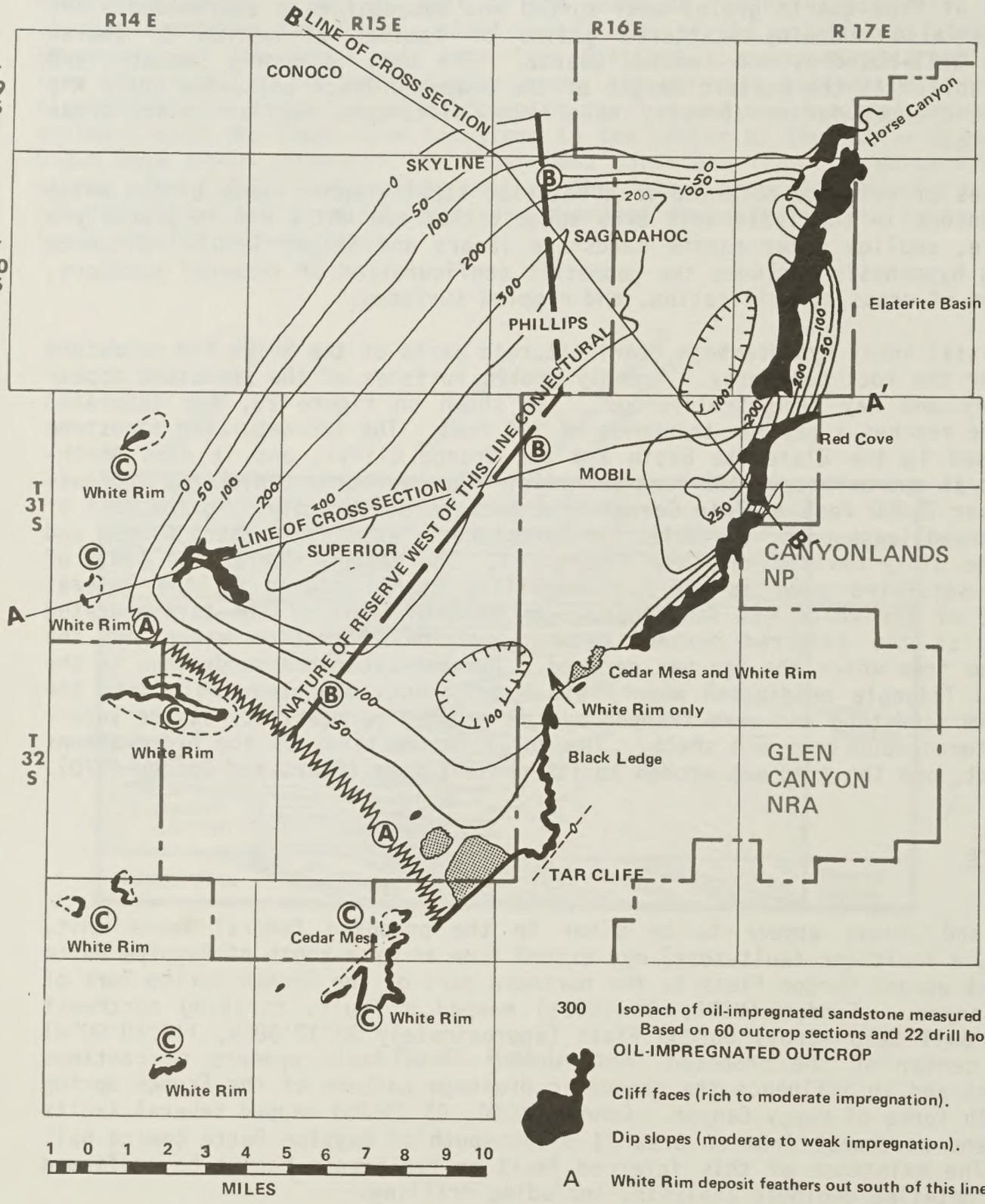
Interstitial heavy hydrocarbons (tar) saturate parts of the White Rim sandstone and color the rock pale gray. Freshly broken surfaces of the sandstone appear dark gray and may be petroliferous. As shown on figure 23, the saturated sandstone reaches a maximum thickness of 300 feet. The tar-saturated sandstone is exposed in the Elaterite Basin and the Orange Cliffs, and it dips northwestward at approximately 100 feet per mile. The overburden thickness increases to over 2,000 feet at Twin Corral Flat because of this dip. To the west of the proposed lease unit, the White Rim sandstone is exposed in Hatch Canyon and along the Dirty Devil River (see figure 24). The eastern (or updip) limit of the tar-saturated sand is at a permeability change caused by the lateral pinchout of the White Rim sandstone. The western limit of the tar-saturated sand is at the inferred contact between original formation water and the petroleum from which the tar was derived. The tar-saturated sandstones in the Tar Sand Triangle originated when fluid hydrocarbons migrated updip into the White Rim sandstone and were trapped by the reduced permeability at the interface between sandstone and shale. The volatile fractions of the hydrocarbons were lost, and the trap was eroded to its present form (Baars and Seager 1970).

Structure

Faults and joints appear to be minor in the proposed federal lease unit. However, a fault (or fault zone) may extend from an area south of Bagpipe Butte northwest across Gordon Flats to the northern part of the French Spring Fork of Happy Canyon. Condon (USDI, GS 1953a) mapped a fault, striking northwest through Bull Seep across Gordon Flats (approximately 38°12'30"N, 110°10'00"W) in the center of the proposed lease unit. This fault appears to continue northwest and to influence the dendritic drainage pattern of the French Spring and South forks of Happy Canyon. Condon (USDI, GS 1953b) mapped several faults that trend northwest from an area 1½ miles south of Bagpipe Butte toward Bull Seep. The existence of this inferred fault or fault zone cannot be confirmed without detailed geologic analysis, including drilling.

TOPOGRAPHY

The proposed federal lease unit lies above and west of the Orange Cliffs. The landscape exemplifies erosion of essentially flat-lying or gently dipping



After Ritzma 1975

300 Isopach of oil-impregnated sandstone measured in feet. Based on 60 outcrop sections and 22 drill holes.

OIL-IMPREGNATED OUTCROP

Cliff faces (rich to moderate impregnation).

Dip slopes (moderate to weak impregnation).

A White Rim deposit feathers out south of this line.

B Reserve west of this line conjectural. No definitive information to relate. Oil-impregnated interval with main deposit to east.

C Pod of oil-impregnated sandstone generally at a lower stratigraphic position and structural elevation than that of main deposit. Not considered in reserve calculation.

Fig. 23. Thickness of Tar-Impregnated Sandstone

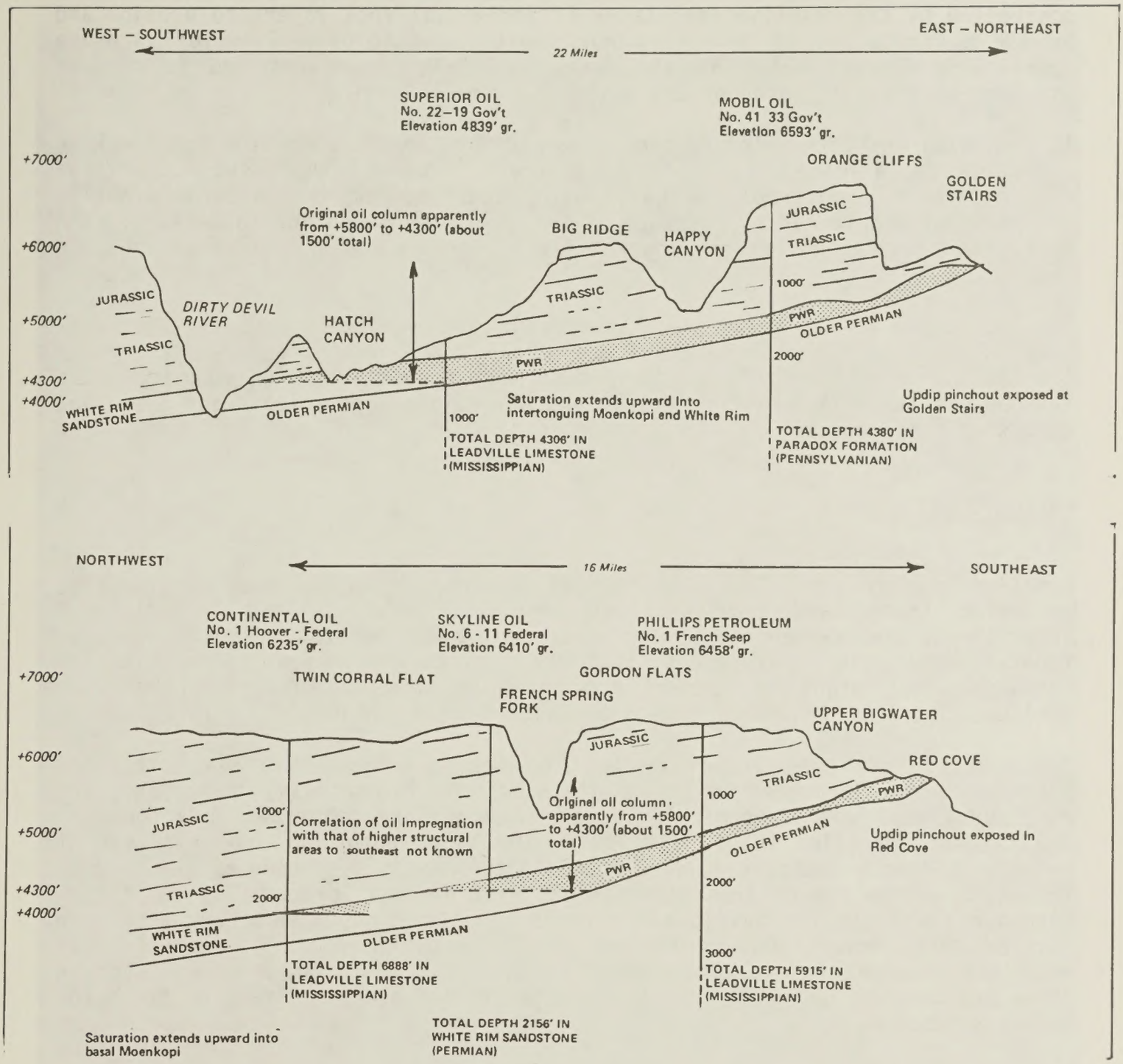


Fig. 24. Oil Column

strata (see figure 25). The sizes and shapes of the topographic features are controlled by the relative resistance of individual rock layers to erosion and by the distribution of joints, minor faults, and folds. Principal erosive agents are flowing water in the Green and Colorado rivers and in smaller streams, periodic flooding of dry washes, and mass wasting.

In the lease unit, the Wingate sandstone and the Kayenta formation top the high mesas (at approximately 6,300 to 6,600 feet). Beneath the massive, vertical cliffs formed by outcrops of the Wingate sandstone and the Kayenta formation are steep slopes formed by outcrops of the Chinle and Moenkopi formations. The White Rim sandstone forms the lower cliff or inner rim (at approximately 5,000 feet).

The topography of the area poses significant constraints for access and operations. Although the mesa tops are essentially flat, access between canyons is limited by vertical cliffs and deep canyons. Access from the mesa tops into the canyons is limited by the terrain and by geologic characteristics that lead to unstable slopes.

PALEONTOLOGY

Detailed surveys and examinations of paleontological resources--fossils, including tracks and trails, plant imprints, fecal pellets (coprolites), invertebrate and vertebrate remains--have not been undertaken in the proposed federal lease unit. Inferences about the type and variety of paleontological resources that might be present are based on known occurrences in similar geologic settings in and around southeastern Utah (Madsen and Miller 1979).

Few fossils have been found in the Glen Canyon group. Two small theropod dinosaurs were discovered in the Navajo sandstone in northeastern Arizona, and dinosaur tracks and taxonomically indeterminate plant materials were found in the Kayenta formation (USDI, GS 1940). Dinosaur footprints and specimens of Unio, a freshwater pelecypod, were found in the Navajo sandstone or the Kayenta formation on the rim of Iron Wash Canyon, west of Lost Spring (USDI, GS 1946). Dinosaur tracks in the Navajo and Wingate sandstones have also been described (Stokes 1978; Brady 1960). Dinosaur tracks have been found on a small butte near the proposed federal lease unit in the Panorama Point area and also in large boulders in Spur Fork Canyon, immediately north of the lease unit, in the Navajo sandstone.

Fossil vertebrates were found in the Petrified Forest member of the Chinle formation in northern Arizona (Gregory 1957). Petrified wood and freshwater gastropods have also been found in this formation, as have bone fragments, crocodilian and amphibian teeth, and freshwater mollusks (USDI, GS 1940 and 1946). Upper Triassic fauna have been described, as have fishes from the Chinle formation (Colbert 1972; Schaeffer 1967). The Moenkopi formation has a small but varied fossil assemblage. Fish, amphibians, reptiles, and plants have been found in the continental facies of the Moenkopi formation (USDI, GS 1972). Reptile tracks and paleo-environments of the Moenkopi formation in Capitol Reef National Park have been studied (Lammars 1964), and fossil tracks of reptiles and amphibians have been described (Peabody 1948 and 1956).

Fig. 25. Westerly View from Orange Cliffs (Happy Canyon in foreground)

The White Rim sandstone and the overlying unnamed red sandstones and shales of the Cutler group are generally unfossiliferous. However, shark teeth have been collected from the Rico formation, a stratigraphic equivalent of the Cutler group (USDI, GS 1974).

Petrified wood weathers out of exposures of the Chinle formation and is found in several locations within the proposed federal lease unit, particularly in the Happy Canyon drainage. Such occurrences are common in southeastern Utah. Petrified wood fragments are also found along the Kayenta formation outcrops from Gordon Flats to the Big Ridge (Sigler and Associates 1983).

In addition to the Mesozoic fossils, tracks, and trails deposited or formed contemporaneously with sedimentation, Quaternary animal remains and coprolites have been found in caves in rocks stratigraphically equivalent to those on the proposed federal lease unit. A cave containing dung from sloths and mammoths was recently discovered in the Navajo sandstone in Glen Canyon National Recreation Area (Martin 1983). Cowboy Cave, immediately north of the lease unit and also in the Navajo sandstone, contained a late Pleistocene dung layer from large herbivores (bison, horse, mammoth, and sloth) dated 13,000 to 11,000 years ago by radiocarbon techniques (Jennings 1980).

ENERGY AND MINERALS

The Tar Sand Triangle is the largest tar sand deposit in Utah, and the White Rim sandstone contains over 99 percent of this estimated resource. Oil impregnation observed in outcrops extends over an area 22 miles long and 1.5 miles wide and averages 250 feet thick (Bowman 1969). Reserves conservatively estimated (based on these outcrop measurements) exceed 1 billion barrels of 8-15 degree API oil. Since oil-impregnated sandstone up to 200 feet thick was encountered in drill holes west of Orange Cliffs, the tar sand may extend over a 100- to 140- square-mile area. Based on subsurface data from limited core drilling, it has been estimated that the Tar Sand Triangle may contain 12.5 to 16 billion barrels of oil (UDNR 1979a). The Interstate Oil Compact Commission (IOCC) has recently revised estimates of measured and speculative oil resources. The IOCC estimates (for the U.S. Geological Survey) indicate 2.5 billion barrels of measured resource and 500 million barrels of speculative resource (IOCC 1983). Table 9 describes reservoir properties and petroleum data for the White Rim sandstone.

Neither in-place nor recoverable petroleum resources can be accurately estimated for the proposed federal lease unit because the extent, thickness, and oil content of the White Rim sandstone within the unit are not well known. It is hypothesized, based on limited information, that the richest portion of the deposit lies within the lease unit. Hydrocarbon recovery methods and efficiencies cannot be accurately quantified until additional geologic exploration and analyses can be conducted.

Gravel for road and general construction is not abundant in or near the proposed federal lease unit. Gravel deposits occur adjacent to the Colorado River and its tributaries as terrace and pediment gravels. The existence of other potential construction materials has not been determined.

Table 9: Reservoir Rock and Petroleum Data for White Rim Sandstone
Tar Sand Triangle, Southeastern Utah

	Reservoir Rock Permeability (Millidarcys)				Pore Saturation (%)		Petroleum Data				
	Before Oil Extraction	After Oil Extraction	Vertical	Porosity (%)	Oil	Water	Gallons/ Ton	Liters/ Metric Ton	Gallons/ Yd^3	Percent Volume	Percent Weight
No. of Samples	121	121	71	121	121	121	121	121	121	121	121
Mean	268.25	340.10	302.44	19.81	32.16	4.67	7.12	24.40	6.00	6.54	2.98
Range	0.03-2,560	0.07-2,790	0.1-2,200	9.7-31.7	5.8-85.4	0.9-31.4	0.5-30.8	1.7-105.6	0.4-25.9	0.5-26.9	0.2-12.9

Source: Campbell and Ritzma 1979, p. 16.

Note: All figures are arithmetic means of data for four wells drilled in T30S, R16E, Wayne County, Utah.
Base data courtesy of Santa Fe Energy Company.

The proposed federal lease unit is part of an area identified as favorable for sandstone-type uranium deposits in the Monitor Butte and overlying Moss Back members of the Chinle formation (Lupe et al. 1982). Fifteen uranium mines or prospects have been identified in and adjacent to the proposed federal lease unit (see table 10), and three of these have produced small tonnages of U_3O_8. The U.S. Department of Energy (DOE) has estimated that the Orange Cliffs area contains an unconditional uranium endowment of approximately 12,700 tons of U_3O_8. Approximately 7,498 tons of U_3O_8 are recoverable in DOE's $50.00 per pound cost category. The proposed lease unit is a small part of the larger Orange Cliffs favorable area, and the portion of uranium resources within the lease unit cannot be accurately estimated because specific geographic and geologic data are not available.

WATER RESOURCES

Surface Water

The region is semiarid, with average annual precipitation ranging from 8 inches at lower elevations to 12 inches on the high mesa tops. Annual potential evapotranspiration may be as much as 40-50 inches and far exceeds the average annual available precipitation. However, precipitation probably exceeds evapotranspiration during the winter months. Less than 1 inch of the total annual precipitation runs off as surface flow (UDNR 1977). Evapotranspiration and groundwater recharge account for the rest. There are no perennial streams within the proposed federal lease unit.

Storms capable of generating flash floods in the area occur at the following estimated frequency (USDOC, NOAA 1973):

Frequency (years)	Probability in Any One Year (%)	Six-Hour Precipitation (inches)
5	20	1.0
25	4	1.4
50	2	1.7
100	1	1.8

Little data are available on the ephemeral streams within the lease unit. The estimated annual runoff for Happy and Millard canyons is 1,920 and 960 acre-feet, respectively (USDOE, LETC 1979a). Flash floods typically occur in response to intense summer rainstorms. Data are sparse on such floods in the lease unit. Estimated peak flow for extremely rare, near-maximum floods could be more than 2,000 cubic feet per second (cfs) for a 1-square-mile drainage and about 10,000 cfs for a 15-square-mile drainage (USDI, GS 1977). High water marks from flooding judged to have occurred within the past five years were noted in April 1983 in the West Fork of Big Water Canyon. The high water marks were about 6 feet above the 35-foot-wide channel. The estimated peak flow from this event appears to have been about 1,500 cfs, or 100 cfs/mi^2, and the flood is estimated at about 15 percent of a near-maximum event.

Table 10: Uranium Occurrences in Salina Quadrangle

Occurrence No.	Name	Location	Host Rock Formation/Member	Deposit Class	Reference
1[a]	Gun Sight Butte group	110°11'26"W 38°04'27"N S20 T31S R16E	Chinle/Shinarump	Sandstone	UV-4
2[b]	Unknown	110°04'50"W 39°07'30"N S32 T301/2S R17E	Cutler Formation	Sandstone	PRR-GJEB-119
3	Robbers' Roost	110°05'45"W 38°09'06"N S19 T301/2S R17E	Chinle Formation	Sandstone	UV-4
4	Lost Hill group	110°20'26"W 38°03'40"N	Chinle Formation	Sandstone	UV-4
5	Hatch Canyon	110°21'30"W 38°05'20"N S30 T31S R15E	Chinle/Shinarump	Sandstone	CRIB
6[a]	Scotty group	110°18'16"W 38°05'21"N S30 T31S R15E	Chinle/Shinarump	Sandstone	UV-4
7	Fanny group	110°17'12"W 38°06'43"N S17 T31S R15E	Chinle/Shinarump	Sandstone	UV-4
8[a]	Hatches	110°18'52"W 38°06'42"N S18 T31S R15E	Chinle/Shinarump	Sandstone	UV-4
9	Happy Canyon	110°18'00"W 38°08'59"N S06 T31S R15E	Chinle Formation	Sandstone	UV-4
10[a]	Cedar Point[c]	110°24'40"W 38°04'50"N S30 T31S R14E	Chinle/Monitor Butte	Sandstone	UV-4
11[a]	Dirty Devil group[c]	110°25'00"W 38°06'00"N S14 T31S R14E	Chinle/Monitor Butte	Sandstone	UV-4
12	Happy Canyon	110°21'10"W 38°09'10"N S35 T30S R14E	Chinle/Shinarump	Sandstone	CRIB
13[a]	Bill Wells claims	110°23'30"W 38°06'01"N S22 T31S R14E	Chinle/Shinarump and Moss Back	Sandstone	UV-4
14[a]	Poison Springs[c]	110°24'04"W 38°06'24"N S23 T31S R13E	Chinle/Monitor Butte	Sandstone	UV-4
15[b,d]	Star group	110°32'00"W 38°07'15"N S12 T31S R12E	Moenkopi Formation	Sandstone	PRR-CEB-R-49

Source: UV--Utah Geological and Mineralogical Survey Uranium-Vanadium Reports 1-23.
CRIB--U.S. Geological Survey Computerized Resources Information Bank.
PRR--U.S. Atomic Energy Commission Preliminary Reconnaissance Report.
Modified From Lupe and Others (1982).
Compiled by Joseph L. Cornellisson and K.J. Franczyk (1979).

Note: Gun Sight is located within proposed federal lease unit.

[a] Uranium occurrence field checked during this study.

[b] Reference location very general.

[c] Production categories, 0-10,000 lb. U_3O_8.

[d] Uranium occurrences sought but not found during this field study.

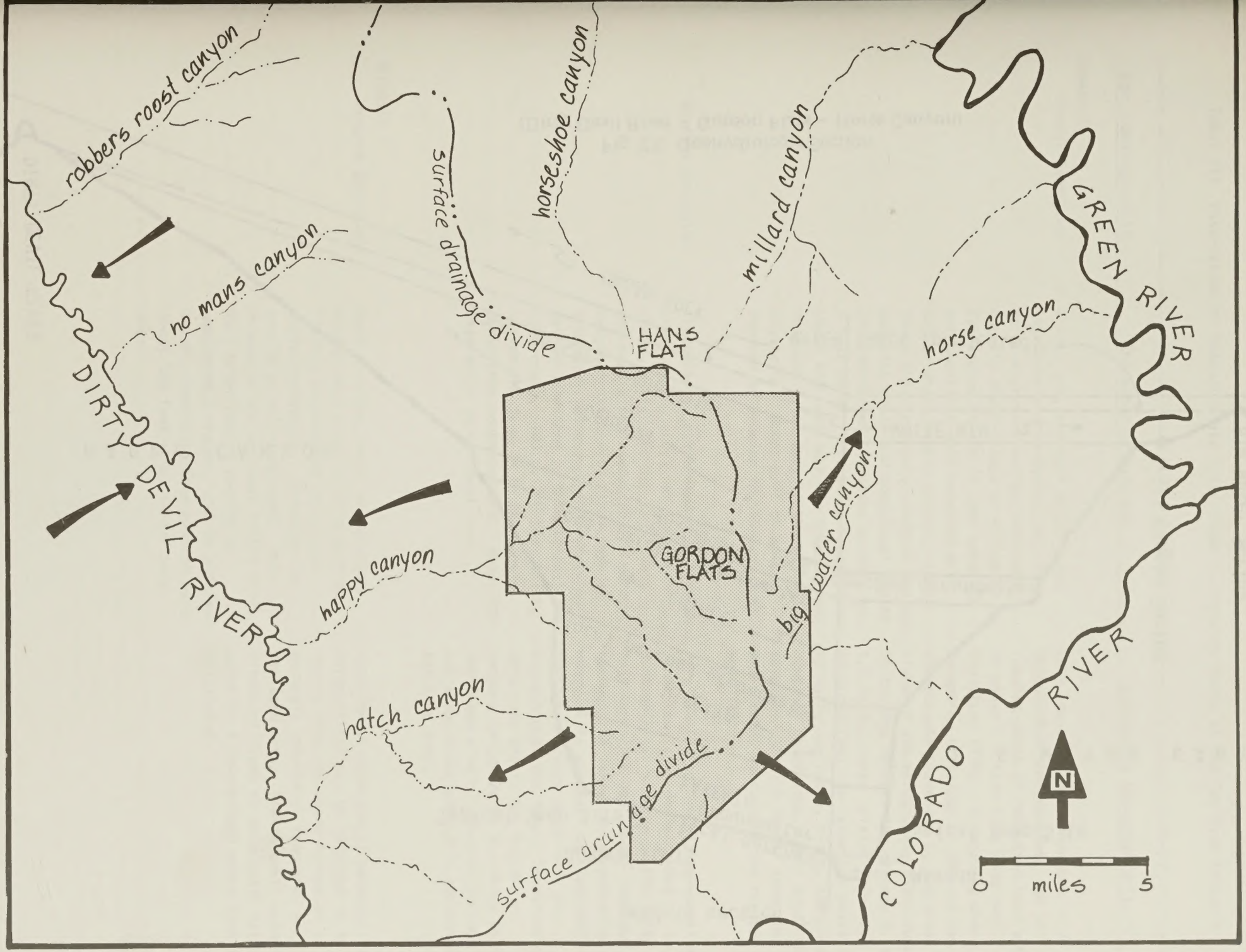
The entire proposed federal lease unit and the surrounding area are a part of the Colorado River system. Most of the area in and around the lease unit drains to the southwest, via Happy and Hatch canyons, to the Dirty Devil River. The southeastern portion drains to the Colorado River, and small portions in the eastern and northeastern sections drain to the Green River via Millard and Horse canyons. The shortest drainages within the lease unit drain directly to the Colorado River (see figure 26).

The average annual flow at the USGS gaging station (09333500) on the Dirty Devil River, located below Happy Canyon Wash, is 96.3 cfs, or 69,800 acre-feet per year. Most of this flow is from the Fremont River and Muddy Creek, which join northwest of the proposed federal lease unit near Hanksville to form the Dirty Devil River. Drainages downstream from Hanksville contribute little additional flow, and some reaches of the Dirty Devil River are frequently dry during the summer because of irrigation withdrawals and natural evapotranspiration (UDNR 1981). Water quality generally degrades progressively downstream. Total dissolved solids (TDS) range from 963 to 3,460 milligrams per liter (mg/l) at gaging station 09333500 (USDI, GS 1983). Based on 1975 data, TDS average about 1,100 mg/l during the winter months, about 1,000 mg/l during spring runoff, and about 2,400 mg/l during the summer and fall (UDNR 1979b). The water typically is high in calcium, sodium, and sulfate. Limited data on suspended sediment concentration in the lower Dirty Devil River suggest that the suspended solids concentration ranges from 10 to 6,140 mg/l during periods of stable flow (UDNR 1979b). Extremely high concentrations occur during short-term periods of high flow (typically less than 1 percent of the time). Average annual sediment discharge on the lower Dirty Devil for the years 1948-54 was 5.6 million tons (USDI, GS 1964a). The Dirty Devil River is currently under study by the Bureau of Reclamation for possible water quality improvement under the Colorado River Basin Salinity Control Act (USDI, BOR 1983).

The Green and Colorado rivers join east of the proposed federal lease unit. The northernmost portion of Lake Powell lies 4 to 5 miles south-southeast of the unit. This river system may be characterized by the USGS gaging station (09380000) on the Colorado River just below Lake Powell at Lees Ferry. The average discharge for the 17 years of the filling of Lake Powell after the completion of the Glen Canyon Dam has been 12,200 cfs, or 8,850,000 acre-feet per year. TDS range from 472 to 655 mg/l, with an average of 553 mg/l.

Groundwater

Rocks that crop out in (and near) the lease unit range in age from Permian to Jurassic, and drill holes have penetrated underlying rocks as old as the Mississippian age. Unconsolidated deposits of Holocene age include thin caps of windblown sand on the mesas and alluvial sand and gravel deposits on canyon floors. Groundwater typically occurs in the older rocks at or below canyon floors, but perched bodies of water also occur on and beneath mesas (see figure 27). Table 11 contains a summary of the rock units and their water-bearing characteristics. Groundwater occurring in rocks of Permian and younger age is potentially usable as potable supply and as tar sand process water. Sparse data on groundwater associated with Pennsylvanian and older rocks in the Tar Sand Triangle indicate that it is saline to briny in quality (UDNR 1981).



Arrows represent probable direction of groundwater movement in the White Rim Sandstone.

Fig. 26. Surface Drainage

TST	40019
DSC	NOV 83

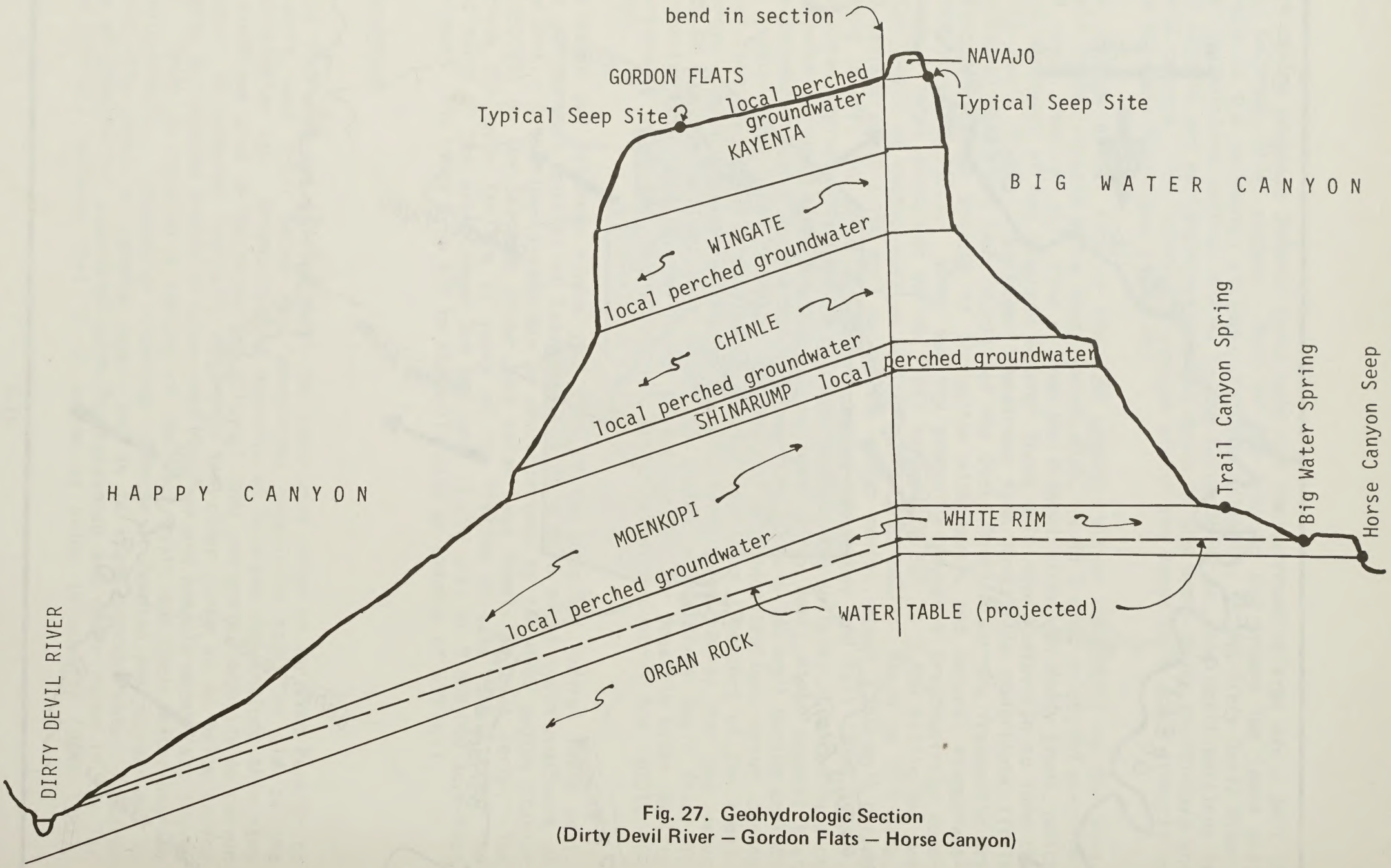


Fig. 27. Geohydrologic Section
(Dirty Devil River — Gordon Flats — Horse Canyon)

Table 11: Description of Geohydrologic Units Known to Underlie Parts of the Tar Sand Triangle

Age	Geologic Unit	Character of Material	Hydrologic Characteristics
JURASSIC			
	Navajo Sandstone	White, tan, and buff thickly and intricately crossbedded very fine to fine-grained eolian sandstone. Locally light-orange or yellow. Calcareous cement in some outcrops but poorly to well-cemented with silica where deeply buried. Local found thin lenticular beds of red to purplish shale and occasional lenses of light-brown limestone as much as 6 feet thick. Thickness ranges from about 450 feet near the Green River to about 1,100 feet in the western mountains. Upper part of unit removed by erosion in tar sand area.	Very low to moderate permeability. Undisturbed, unfractured, and unleached parts of formation have a K^1 of about 0.5 ft/d (see Hood and Danielson 1979). Fracturing where formation is folded or faulted has effectively increased K, but areas of higher K are erratically distributed. In the Red Desert, the average K is 1.7 ft/d. Large yields can be obtained from the formation where it is fully saturated, thick, and under confined conditions. Only basal beds saturated locally in tar sand area where water contains a few hundred mg/l TDS.
	Kayenta Formation	Irregularly interbedded red, reddish-brown, buff, gray, and lavender shale, siltstone, and fine- to coarse-grained sandstone, in part conglomeratic, with minor beds of limestone. Contact with overlying Navajo Sandstone is transitional in some areas. 180 to 350 feet thick, increasing from NW to SE. Shale diminishes southeastward. About 300 feet thick in tar sand area.	Very low (?) to low (?) permeability. Formation is a confining bed of lower permeability relative to the adjacent sandstone aquifers. Leakage through the formation is probably where it is sandiest or fractured. Springs or seeps occur near the contact with the Navajo Sandstone on mesa tops and in the bottoms of canyons tributary to the Dirty Devil and Green rivers. Several springs and seeps occur near this contact in tar sand area.
TRIASSIC			
	Wingate Sandstone	Reddish-brown, buff, and grayish-orange very fine- to fine-grained thickly crossbedded calcareous eolian sandstone. Formation is poorly to well-indurated. Most exposures are vertical cliffs with dark brown desert varnish on weathered surfaces. 270 to 400 feet thick, increasing from west to east. About 300 feet thick in tar sand area.	Very low to moderate(?) permeability. Permeability can be inferred to be low to moderate where formation is strongly jointed or fractured west to tar sand area. Yields small quantities of fresh to moderately saline water to a few springs where rock is is jointed.

Age	Geologic Unit	Character of Material	Hydrologic Characteristics
	Chinle Formation Church Rock (?) Mbr. Owl Rock Member Petrified Forest Mbr. Moss Back Member Monitor Butte Member Shinarump Member Temple Mountain Mbr.	Seven members or lithologic equivalents mostly of fluvial and lacustrine origin; not all members present in any given locality. Mudstone, siltstone, sandstone, and some conglomerate in various shades of purple, red, and brown. Moss Back Member: Yellowish-gray fine- to medium-grained lenticular conglomeratic sandstone; minor mudstone seams, limestone conglomerate, and coaly material. Shinarump Member: Light-gray to yellow fine- to coarse-grained sandstone and conglomerate sandstone with minor mudstone lenses and plant remains. Total thickness of Chinle formation is 215 to 550 feet, increasing from NE to SW. About 500-520 feet thick in tar sand area.	Very low to low (?) permeability. Most of formation is too fine grained to accept much recharge; conversely, it enhances surface runoff and contributes much sediment to surface water. May yield small amounts of water to seeps. Seeps reported in sand area.
	Moenkopi Formation Upper part	Reddish-brown even-bedded fissile mudstone and siltstone and fine-grained sandstone with thin layers and veins of gypsum and anhydrite. Locally petroliferous. 200 to 775 feet thick.	Moenkopi as a whole has very low to low (?) permeability. Sandstone (?) units in and near outcrop areas yield small quantities of fresh to slightly saline water. Records from petroleum-test wells show that the formation, where deeply buried, yields moderately to very saline water of mixed types.
	Sinbad Limestone Mbr.	Yellowish-gray and tan thin- to medium-bedded colitic dolomite and limestone with minor amounts of siltstone and sandstone. 12 to 200 feet thick.	Probably very low permeability in most areas; where the limestone is near the surface or has been strongly fractured, groundwater circulation probably has caused cavernous development and thus enhanced the permeability. Samples from petroleum test wells indicate the limestone, where deeply buried, contains moderately to very saline water.
	Lower part of Moenkopi Formation	Light-reddish-brown, yellow, and green even-bedded siltstone and sandstone containing gypsum veinlets; a chert pebble conglomerate at base 20 to 140 feet thick.	Several coreholes in tar sand area report groundwater in Moenkopi.

Age	Geologic Unit	Character of Material	Hydrologic Characteristics
		Total thickness of the Moenkopi formation is 360 to 1,000 feet or more, increasing from east to west. About 400-450 feet thick in tar sand area.	
PERMIAN			
	Cutler Formation White Rim Sandstone Member	Equivalent to upper part of Coconino Sandstone. White, gray, and buff fine- to medium-grained eolian sandstone. 0 to 230 feet thick. About 200 feet thick in tar sand area.	Testing of this sandstone in petroleum test wells produced water at most locations. Two samples from wells in T30S, R15E, were fresh. Water was mostly of mixed types, but several were of the sodium sulfate type. Lower 32 feet saturated in Altex well (Sec. 26, T30S, R16E), calcium bicarbonate water, 970 mg/l TDS.
	Organ Rock Tongue or Member	Reddish-brown siltstone and thin-bedded fine-grained sandstone. 0 to 900 feet thick.	Very low (?) permeability.
	Cedar Mesa Sandstone Member	Yellowish-gray, reddish-orange, and reddish-brown friable fine- to coarse-grained thickly crossbedded eolian sandstone, with minor beds of red sandy shale and gray cherty limestone. 750 feet thick.	Hans Flat R.S. well water Ca-Na-SO_4 type, contains 1,720 mg/l TDS. Several springs in Maze-Ernies Country-Waterhole Flat discharge from Cedar Mesa, water typically a few hundred mg/l TDS.
	Halgaito Tongue or Member	Thin-bedded mudstone and siltstone. Crops out along canyon of Colorado.	Very low (?) permeability. Characteristics unknown. The only available water sample was moderately saline and of the sodium sulfate type.
	Rico Formation	Reddish-brown and greenish-gray fine- to coarse-grained crossbedded sandstone; gray and grayish-green thin- to thick-bedded cherty limestone; red and purple shale and siltstone. In some petroleum tests, this section is identified as the Elephant Canyon Formation, or simply as "Wolfcamp" or "Wolfcamp carbonates."	Very low (?) permeability. No water samples, but water probably is saline.

Age	Geologic Unit	Character of Material	Hydrologic Characteristics
PENNSYLVANIAN			
	Hermosa Formation Upper member (includes Honaker Trail Formation [Wengerd & Methany 1958])	Gray thin- to thick-bedded dense to coarsely crystalline cherty limestone, interbedded with gray and brown massive to thin-bedded sandstone, siltstone, and sparse beds of gray and red shale. 200 to 1,300 feet, increasing eastward.	Very low (?) permeability. Water sample from petroleum test well (D-25-15)22aca-1 was very saline and of the sodium chloride sulfate type.
	Paradox Member of the Hermosa Formation	Salt, gypsum, anhydrite, black shale, and gray sandstone and limestone. Thickness increases eastward from 0 to 2,500 feet as determined from well logs (also see Hanshaw & Hill 1969).	Very low to moderate(?) permeability; permeability very low except where fracturing has allowed water circulation to dissolved salt, gypsum, and limestone. Water samples analyzed were moderately saline of the sodium sulfate type and very saline to briny water of the sodium chloride type.
	Lower member Pinkerton Trail Formation	Mainly dark-gray limestone, dolomite, and shale. 0 to 200 (?) feet thick.	Very low (?) permeability. Water sample from well (D-30-13)4dcb-1 was brine of sodium chloride type.
	Molas Formation	Variegated claystone and shale; siltstone and conglomerate, includes limestone and chert regolith on karst surface in upper 10 to 100 feet of underlying Mississippian rocks, wherever Mississippian is or was present. 20 to about 580 (?) feet thick.	Very low permeability; probably confines water in Mississippian rocks. No water quality data.
MISSISSIPPIAN (Following are terms used by various petroleum companies) Redwall Limestone Leadville Limestone Madison Limestone or Group		Mainly limestone and dolomite. Upper surface has karst topography and some internal zones are locally (?) cavernous. 200 (?) to about 1,150 feet thick at wells in area.	Very low to high (?) permeability. Most of formation should be of very low permeability, but where solution of limestone and dolomite has created cavernous zones, permeability may be high. Almost all petroleum test wells that penetrated and were tested in these rocks recovered relatively large amounts of water. Well (D-26-17)5ccc-1 flowed during testing. Water samples recovered from wells west of the tar sand area were slightly to very saline of the sodium sulfate, magnesium chloride, and sodium calcium chloride types. The remaining samples were moderately saline to briny and are of the sodium chloride or sodium magnesium chloride type.

Age	Geologic Unit	Character of Material	Hydrologic Characteristics
DEVONIAN			
	Ouray Limestone	Massive dense argillaceous limestone and thin clayey shale; locally sandy with sandstone. Thickness reported from wells in area ranges from about 90 to about 400 feet thick.	Very low (?) permeability. No water quality data.
	Elbert Formation	Limestone, shale, and (?) basal sandstone. Thickness reported for wells in area ranges from 260 to about 850 feet.	Very low (?) permeability. Water sample from well (D-26-7)19bbd-1 contained moderately saline water of the sodium sulfate type. The petroleum test well was sampled across the Elbert-Lynch contact.
CAMBRIAN			
	Lynch Dolomite	Chiefly dolomite and limestone. About 500 feet thick.	Very low (?) permeability. Water quality assumed to be similar to that in Elbert formation.
	Ophir Shale	Micaceous (?) shale and dark limestone. 600 to 700 feet thick.	Very low permeability. No water quality data.
	Tintic Quartzite	Mainly reddish quartzite or quartzitic sandstone, some (?) siltstone and (?) conglomerate. About 200 feet thick.	Very low permeability. No water quality data.
PRECAMBRIAN			
		Found at relatively shallow depths in San Rafael swell. Two logs available for well (D-23-11)27bbd-1; one log records "quartz biotite schist," the other records granite at 4,370 feet below land surface. Rock undescribed but found at greater depths in wells (D-25-13) 14bbc-1 and (D-25-14)22cdd-1.	Very low permeability. No water quality data.

Source: Adapted from Hood and Danielson (1981), table 1.

[1] K = hydraulic conductivity.

Limestone of Mississippian age (Redwell-Leadville-Madison) and older units may be potential zones for injection of wastewater.

The geologic structure of the area influences the occurrence and movement of groundwater. The regional dip is to the northwest from outcrop areas along Orange Cliffs. Recharge from rainfall or snowmelt near or on the outcrops

first moves vertically to a saturated zone, then downgradient. Secondary structural features such as faults and fractures affect movement locally, as they tend to enhance the permeability of the rocks along their trends. The tar occurring in the White Rim sandstone also affects groundwater movement. The oil fills interstitial space, decreasing both the permeability and the porosity of the sandstone. Big Water Spring and two nearby unnamed springs issue from the upper part of the White Rim sandstone in the Elaterite Basin. These springs may be discharging from a groundwater body perched on very tight tar-saturated beds in the White Rim sandstone. Data from several drill holes in the area indicate that groundwater occurs in the overlying Moenkopi formation. This and the calcium sulfate character of the water suggest that the source of Big Water Spring may be the Moenkopi and the uppermost White Rim sandstone. Data are not available to determine if perched groundwater also occurs on the tar-saturated zones within the proposed lease unit.

The few mesa-top springs appear to discharge from the Navajo-Kayenta contact, where silty or shaley beds in the Kayenta formation create a local body of perched groundwater (see figure 27). These perched groundwater bodies are recharged locally by snowmelt and rainfall infiltration. Although groundwater data from drilling records are sparse, water is reported or inferred to occur locally at the base of the Wingate sandstone, in the lower part of the Chinle formation, in the White Rim sandstone, in the lower members of the Cutler group, and in the older, deeper formations. Springs and seeps east of the proposed unit (Elaterite Basin, the Maze, Ernies Country, and Waterhole Flat) indicate that groundwater of usable quality occurs in the Moenkopi and older formations.

Sparse data are available on groundwater movement, and additional information is required before specific statements on the direction of groundwater flow can be made. Also, sparse data are available on the elevation of the water table in the area from which direction of movement can be inferred. However, data from Altex #1 well indicate that about 32 feet of the lower White Rim sandstone is saturated, and the water level elevation is about 5,000 feet. This well is cased and cemented from the surface to the top of the White Rim. In the Elaterite Basin, 5 or 6 miles northeast of Altex #1, three springs discharge from the uppermost White Rim sandstone at elevations of 5,000 to 5,060 feet. These springs may be perched on tar-saturated zones in the White Rim. In March 1983, small quantities of groundwater appeared to be discharging from the lower 30 to 50 feet of the White Rim sandstone at the base of a cliff at the head of Horse Canyon, 1 mile east of these springs, at an approximate elevation of 4,800 feet. There appears to be a potential gradient of about 30 feet per mile in the groundwater system between Altex #1 and the head of Horse Canyon. If the White Rim sandstone at the three springs is entirely saturated, the groundwater gradient appears to be nearly flat between Altex #1 and the springs. However, recharge to the exposed White Rim between the Altex well and the springs may have raised the water table to form a divide. The water level in a well completed in the White Rim approximately 5 miles west of Altex #1 reportedly stands at an elevation of about 4,070 feet, indicating a potential gradient between wells of about 170 feet per mile (UDNR 1981).

The White Rim sandstone crops out along the Dirty Devil River at an elevation of approximately 3,900 feet near the mouth of Happy Canyon. A groundwater gradient of 70 feet per mile could exist from Altex #1 toward the Dirty Devil River. Known and postulated directions of groundwater flow are shown on figure 26.

Approximately 5 miles northwest of Altex #1, at the Hans Flat ranger station, the water level was reported at an elevation of about 4,000 feet in 1973 in a well completed in the Cutler group (probably in the Cedar Mesa sandstone member). This water level elevation is almost 1,000 feet lower than the water level in the White Rim sandstone at Altex #1, which strongly suggests that the degree of hydraulic connection across the Organ Rock shale unit may be slight, but that groundwater may move downward from the White Rim sandstone.

The annual volume of recharge is a small percentage of both annual precipitation and the amount of groundwater in storage. Geohydrologic conditions suggest that almost all recharge occurs on sandy mesa tops and along canyon floors. Most recharge on mesas probably occurs as direct infiltration during snowmelt and rainstorms. Recharge rates from direct precipitation on outcropping Navajo sandstone in the San Rafael swell northwest of the Tar Sand Triangle was calculated at 0.04-0.06 inches per year, or 1,100-1,600 gal/acre/yr (Hood and Patterson 1982). In the canyons, some of the ephemeral surface flow infiltrates into the alluvium and sandstone bedrock of the stream channels. No data are available on total recharge in the area, but it's possibly in the range of a few hundred acre-feet per year. Within the proposed unit, neither the recharge areas nor the direction of flow to discharge areas are well documented. Some of the recharge on the mesa tops moves laterally as perched groundwater at shallow depths and discharges at local springs and seeps. Flint Seep and French Spring are examples of such discharge (see figure 27). In addition, some of the recharge moves downward to the base of the Wingate sandstone where it forms local perched groundwater bodies, which discharge mainly by evapotranspiration on the downdip side of the mesas (Hand 1979).

Beneath the mesas, groundwater in the Shinarump, Moenkopi, and White Rim formations may be moving generally to the west and southwest to discharge to the Dirty Devil River (see figure 26). Sparse data suggest that the base flow in the Dirty Devil River increases in the reach where the stream crosses these formations southwest of the lease unit (UDNR 1981). East of Orange Cliffs, springs discharging from the lower Moenkopi and older formations in an updip outcrop area indicate that groundwater in this area is moving eastward.

Large quantities of groundwater are in storage to the west of the proposed unit. The thick sandstone aquifers in the lower Dirty Devil River Basin contain an estimated 550 million acre-feet of groundwater (UDNR 1979c). Groundwater storage within the proposed unit can only be speculatively estimated because the areal distribution, thickness, and specific yield of saturated rocks are not known in detail. Where the rock units are known to be saturated, a reasonable estimate of storage can be made. For example, Hood and Danielson (1979) estimated that where the Coconino sandstone (similar to the White Rim) is fully saturated, it is 700 feet thick, with a known 20 percent porosity and 8 percent specific yield; the unit would contain 240 million acre-feet of groundwater in storage over the 2,700-square-mile lower Dirty Devil drainage area; this equates to almost 90,000 acre-feet per square mile. However, nowhere in the proposed federal lease unit is the White Rim this thick or known to be fully saturated. Sparse drill hole data show that the lower part of the White Rim is saturated beneath a part of the area. Assuming that on the

average the basal 40 feet of the White Rim is saturated and the porosity is 20 percent, total storage in the 54,000-acre area considered for conversion would be about 430,000 acre-feet, or more than 5,000 acre-feet of groundwater in storage per square mile. The estimated specific yield of the White Rim is about 8 percent (UDNR 1979c), suggesting a recoverable groundwater volume of 170,000 acre-feet for the White Rim. Assuming that the lower 100 feet of the White Rim is saturated in the western downdip part of the proposed unit, but that the average porosity is 10 percent and the specific yield is reduced to 5 percent because of tar filling part of the formation, the computed storage would be about 6,400 acre-feet per square mile. Usable storage would then be about 3,200 acre-feet per square mile.

Data on groundwater quality in the proposed federal lease unit are limited (see table 12 for summary). TDS values range from several hundred mg/l at French Spring to a few thousand mg/l at Big Water Spring. Three samples from the White Rim sandstone contained 900 to 970 mg/l TDS. Groundwater in deeper zones may locally be of poorer quality. Water in the lower part of the Cutler group from the Hans Flat ranger station well contains 1,720 mg/l TDS. Groundwater issuing from springs in the Cutler group (below the White Rim) east and south of the lease area is of good quality, generally containing from a few hundred to several hundred mg/l TDS. Groundwater can be used for wildlife and livestock watering and locally for drinking water for humans. The concentration of TDS at some sites is in excess of the maximum of 500 mg/l TDS recommended for potable water (USPHS 1962), although the water can be used locally for drinking water for humans if no alternate source is available.

SOILS

The soils of the proposed federal lease unit are of the red and gray (sierozem) desert soil group (Jenne 1941). These soils were formed primarily by physical weathering. The dry climate retards chemical weathering of the sandstone parent material, so soils are formed and deposited in this area chiefly by wind (aeolian) and water erosion (alluvium). Soil columns consist chiefly of undifferentiated sandy regolith; regolith is a soil layer over bedrock, where there has been little development of mature soil horizons (Loope 1977).

The soils in the lease unit can be distinguished by their physiographic location (i.e., mesa tops, talus slopes, or canyon bottoms; see figure 28). Soils on the mesa tops were formed from wind deposition of sands and are generally quite shallow (less than 20 inches). The soils in the extreme northwest corner of the unit are deeper (in excess of 25 inches) and more similar to the San Rafael desert soils found north of the lease unit (Santa Fe Energy Company et al. 1982). In the canyon bottoms, the regolith layer is deeper because deposition increases in these more sheltered areas. Talus slopes are comprised of a mixture of rock debris, boulders, and colluvium. The major soils are briefly described in this section; however, detailed profiles of the soil types found within the proposed unit are contained in appendix D, as well as a soils map (see figure 54).

Table 12: Selected Water Quality Data for Aquifers in the Vicinity of the Federal Lease Unit

Location	Date of Sample	Discharge (gpm)	Total Depth of Well (ft)	Depth to top of Sample Interval (ft)	Depth to Bottom of Sample Interval (ft)	Temperature (°C)	Dissolved Silica (SiO_2) (mg/l)	Dissolved Iron (Fe) (ug/l)	Dissolved Calcium (Ca) (mg/l)	Dissolved Magnesium (Mg) (mg/l)	Dissolved Sodium (Na) (mg/l)	Sodium plus Potassium (Na^+, K) (mg/l)	Dissolved Potassium (K) (mg/l)	Bicarbonate (HCO_3) (mg/l)	Carbonate (CO_3) (mg/l)
A. Aquifers of Permian Age and Younger															
(D-27-14) 5bca-1	12/05/55	--	5,940	2,142	2,256	--	--	--	34	27	--	1,880	--	1,880	505
17ccb-1	10/12/59	--	6,523	2,731	2,826	--	--	0	496	272	--	901	--	1,240	0
(D-27-15)32adb-1	10/08/80	--	8,096	2,330	2,366	--	--	--	--	760	--	108	--	10	120
(D-27-16)20bdc-S1	12/12/69	E3	--	--	--	15.5	8.5	10	30	26	4.1	--	3.7	196	0
(D-29-13) 7abc-S1	12/21/76	--	--	--	--	16.5	9.3	290	35	47	41	--	8.6	332	--
(D-29-15)14dbb-S1	12/22/57	.5	--	--	--	9.	8.6	10	28	22	4.8	--	2.1	174	0
(D-29-16)28cbc-1	12/05/73	--	2,750	--	--	14.5	8.9	70	270	53	180	--	52	304	0
(D-30-13) 4dcb-1	09/01/71	--	6,128	2,192	2,240	--	--	0	720	188	637	--	104	1,320	0
(D-30-15)13cbd-1	06/29/66	--	760	720	760	--	8.3	--	40	35	--	272	--	714	0
23dbc-1	06/29/66	--	1,618	750	1,615	--	6.4	--	80	88	--	109	--	320	0
(D-30-16) 3aab-S1	05/57	1.0	--	--	--	9.5	8.9	0	43	13	11	--	1.5	165	0
	12/03/69	.7	--	--	--	15.5	11.	40	64	26	54	--	2.1	212	0
(D-30-16)26	05/81(?)	--	1,666	1,624	1,666			100	28	35	156	--	50	573	3.6
(D-30-17) 4ccb-S1	04/12/83	.2	--	--	--	12.	9.9	40	350	190	150	--	21		
(D-30-17) 5cdc-S1	04/12/83	1.4	--	--	--	6.5	9.2	30	140	230	440	--	35		0
(D-30-17) 9cbc-S1	04/12/83	1.1	--	--	--	14.	11.	30	270	160	120	--	21		0
(D-31-13) 9bcd-S1	06/20/57	3.	--	--	--	17.5	9.1	0	25	28	46	--	8.5	275	0
	07/26/76	4.1				19	8.9	40	25	30	47	--	9.4	274	0
B. Aquifers of Pennsylvanian Age and Older															
(D-27-13)30abc-1	05/62	--	7,664	6,549	6,685	--	--	0	400	535	--	3,070	--	537	0
36cdc-1	12/20/58	--	6,820	6,712	6,820	--	--	0	1,200	512	4,000	--	130	664	0
(D-27-15)32adb-1	12/23/60	--	8,096	5,900	5,990	--	--	--	1,200	1,760	--	7,380	--	597	0
35bcc-1	10/18/56	--	5,534	5,170	5,410	--	--	0	1,920	0	--	3,130	--	627	0
(D-27-16)33acb-1	11/07/61	--	6,867	5,894	5,994	--	--	0	1,200	438	--	9,110	--	853	0
(D-29-15)20add-1	10/04/58	--	6,886	6,685	6,846	--	--	4,000	2,100	471	30,000	--	218	586	0
(D-30-13) 4dcb-1	09/03/71	--	--	6,043	6,129	--	--	0	1,330	361	7,340	--	250	915	0
(D-30-13) 4dcb-1	09/02/71	--	--	5,540	5,610	--	--	0	1,940	723	41,500	--	420	281	0

Source: Modified from Hood and Danielson (1981).

Note: The text describes the well and spring numbering system.
Location: D - deepened, S - plugged back.
Discharge: E - estimated
Dissolved solids, sum of constituents: Sum of determined constituents shown, plus trace elements, if any.
Analysis By: CG - Chemical and Geological Laboratories, CO - Continental Oil Co., GS - Geological Survey, RM - Rocky Mountain Engineering, Inc.
Specific Conductance: In micromhos per centimeter at 25°C

Location	Sulfate (SO_4) (mg/l)	Dissolved Chloride (Cl) (mg/l)	Dissolved Fluoride (F) (mg/l)	Dissolved Nitrate (NO_3) (mg/l)	Nitrate plus Nitrate (mg/l)	Dissolved Ortho-Phosphate (PO_4) (mg/l)	Dissolved Boron (B) (ug/l)	Dissolved Solids (Residue at 180°C) (mg/l)	Dissolved Solids Sum of Constituents (mg/l)	Specific Conductance (Micromhos)	Hardness (Ca, Mg) (mg/l)	Non-Carbonate Hardness (mg/l)	Sodium Absorption Ratio (mg/l)	pH (Units)	Analyzing Sample
A. Aquifers of Permian Age and Younger															
(D-27-14) 5bca-1	988	620	--	--	--	--	--	5,970	4,980	7,330	200	0	--	8.6	CG
17ccb-1	2,900	199	--	--	--	--	--	6,010	5,380	8,730	2,400	1,300	--	6.0	CL
(D-27-15)32adb-1	1,780	600	--	--	--	--	--	3,470	--	4,300	--	--	--	10.5	RM
(D-27-16)20bdc-S1	14	6.2	.4	.3	--	--	160	200	189	353	180	19	.1	7.4	GS
(D-29-13) 7abc-S1	55	23	.3	--	.09	0	50	--	384	640	280	9	1	--	GS
(D-29-15)14dbb-S1	15	10	.1	2.6	--	--	10	179	179	318	159	16		7.3	GS
(D-29-16)28cbc-1	960	45	.2	--	.03	.09	--	--	1,720	2,330	890	640	2.6	7.7	GS
(D-30-13) 4dcb-1	1,700	880	--	--	--	--	--	--	4,880	6,000	2,600	1,500	5.5		
(D-30-15)13cbd-1	119	90	--	.4	--	--	--	946	916	1,490	245	0	7.6	7.6	GS
23dbc-1	432	60	--	.4	--	--	--	984	933	1,410	560	298	2	7.7	GS
(D-30-16) 3aab-S1	22	18	.1	6.5	--	--	10	214	205	362	161	26	.4	7.1	GS
	24	133	.1	9	--	--	0	504	427	790	268	94	1.4	7.9	GS
(D-30-16)26	73	51	--	--	--	--	--	970	1,108					8.6	CL
(D-30-17) 4ccb-S1	1,600	84	.3						2,510	2,980	1,700	1,500	1.6	7.8	GS
(D-30-17) 5cdc-S1	1,700	150	0.7	--	0.1	--	--	--	2,840	3,700	1,300	1,100	5.3	8.2	GS
(D-30-17) 9cbc-S1	1,200	74	.4		.63			--	1,980	2,470	1,300	1,100	1.4	8.0	GS
(D-31-13) 9bcd-S1	44	12	.3	3.7	--	--	60	305	312	528	176	0	1.5	7.4	GS
	50	12	.5	--	1.20	0	90	--	323	550	190	0	1.5	7.6	GS
B. Aquifers of Pennsylvanian Age and Older															
(D-27-13)30abc-1	320	6,460	--	--	--	--	--	--	11,000	20,400	3,200	2,800	--	6.0	CL
36cdc-1	3,100	7,100	--	--	--	--	--	17,400	16,400	22,700	5,100	4,600	24	7.4	CO
(D-27-15)32adb-1	3,840	15,500	--	--	--	--	--	30,500	30,000	--	10,000	9,800	--	7.3	CL
35bcc-1	3,240	5,510	--	--	--	--	--	--	14,100	14,300	4,800	4,300	20	5.0	CL
(D-27-16)33acb-1	2,200	15,300	--	--	--	--	--	--	28,700	44,400	4,800	4,100	57	7.0	CL
(D-29-15)20add-1	5,900	46,500	--	--	--	--	--	--	85,500	118,000	7,200	6,700	154	7.7	CO
(D-30-13) 4dcb-1	4,420	11,200	--	--	--	--	--	--	25,400	31,500	4,800	4,100	46	8.0	CG
(D-30-13) 4dcb-1	6,370	65,000	--	--	--	--	--	--	116,000	120,000	7,800	7,600	204	7.3	CG

The Begay soils are a deep (45-70 inches) depositional soil found on the mesa tops. These soils are coarse-loamy, mixed, mesic Ustollic Camborthids and cover approximately 6 percent (3,290 acres) of the lease unit. Soils at Flint and Gordon flats are representative of this type. The dominant vegetative cover is sagebrush and grasses that prefer deep, well-drained soils.

The Mellenthin soils, also found on the mesa tops, cover approximately 32 percent (17,289 acres) of the lease unit. These soils are much shallower than the Begay soils and are loamy-skeletal, mixed, mesic Lithic Ustollic Calciorthids. The principal vegetative cover is pinyon-juniper with sparse understory of desert holly, Morman-tea, and cliffrose.

Soils found on talus slopes and at the cliff bases were formed by deposition of weathered material from the cliffs above. These soils are moderately deep (18 inches) and support a thin vegetative cover of pinyon-juniper, blackbrush, other shrubs, grasses, and forbs.

Travessilla soils are shallow and principally found on valley benches. Permeability and runoff are moderately rapid, and water erosion potential is high. These soils cover approximately 10 percent of the lease unit (5,499 acres). They are classified similar to the Rizno soils--Lithic Ustic Torriorthents.

The Rizno soils are shallow and principally found at lower elevations in the southern part of the unit (in the Sunset Pass area). The soil depth is not uniform and exposed bedrock commonly occurs. Because permeability is often restrictive and runoff rapid, these soils are the most susceptible to water erosion. The Rizno soils are loamy, mixed, mesic Lithic Ustic Torriorthents and cover approximately 12 percent of the lease unit (6,287 acres). There are minor amounts (610 acres) of Mido soils within the lease unit. Like the Begay soils, the Mido soils are highly susceptible to wind erosion once disturbed. These soils are mixed, mesic Ustic Torripsamments.

Cryptogamic soil crusts are found on all soil types within the lease unit. These crusts are composed of nitrogen-fixing bacteria and algae that bind soil particles into lumpy, blackish crusts that are resistant to wind and water erosion (see figure 29). The development of cryptogamic crusts is correlated to the percentage of silt in the soil (Anderson, Harper, and Holmgren 1982); the higher the silt content, the more likely the development of crusts. Cryptogamic crusts are generally more extensive on valley bottom soils. The valley floors generally have a higher percentage of silt and clay because they are located in or below the Chinle formation, which has a high clay content and weathers to form silt. Crust coverage on valley bottom soil units ranges up to 11 percent and averages 1 to 5 percent elsewhere (Santa Fe Energy Company et al. 1982).

Two soil groups (Begay and Mido soils) within the lease unit have been rated as highly susceptible to wind erosion once the surface has been disturbed (USDA, SCS 1983). All soils within the unit are rated as poor or very poor for reclamation because of their poor seeding potential, shallowness, low fertility rating, low water retention ability, and low water availability.

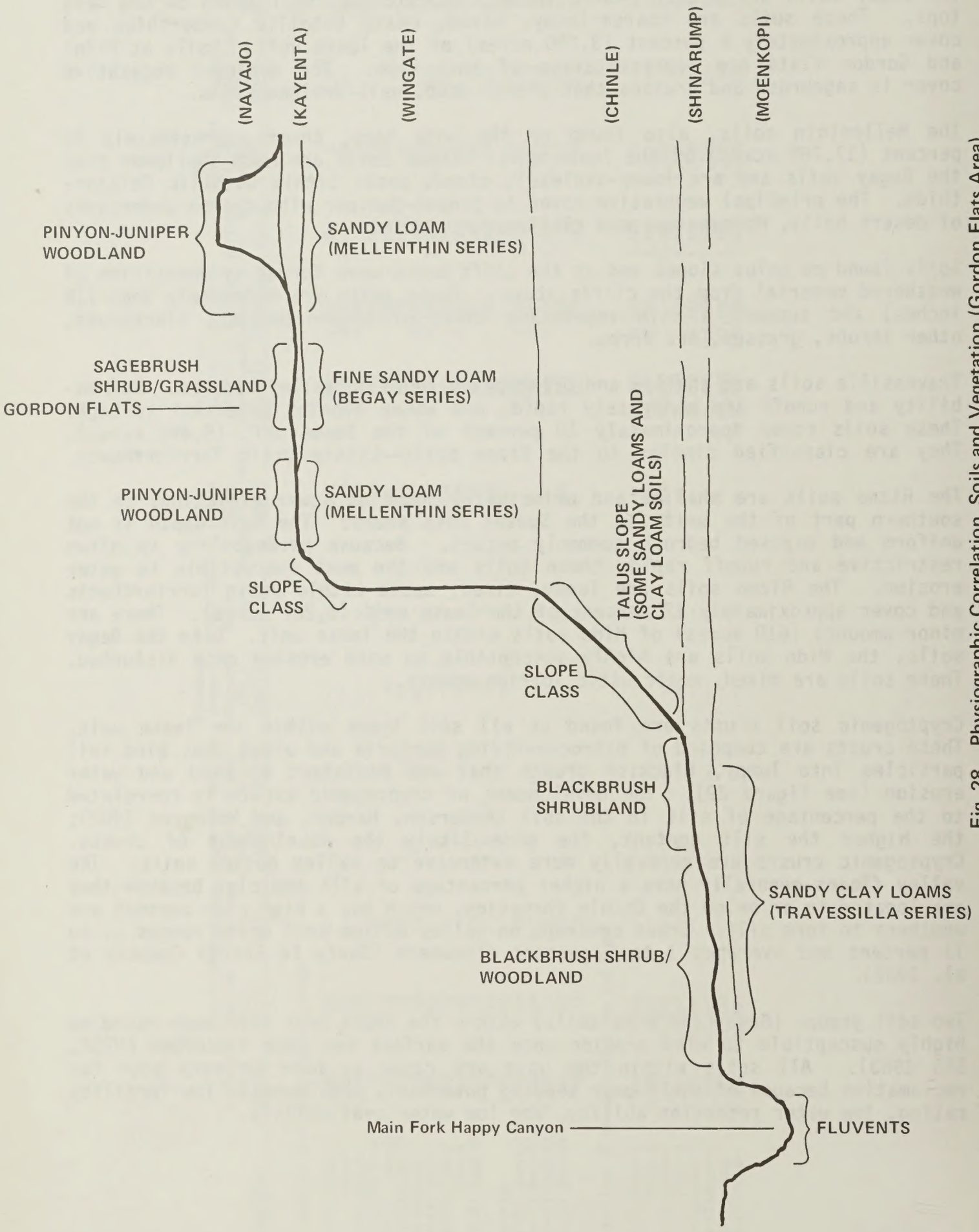


Fig. 28. Physiographic Correlation, Soils and Vegetation (Gordon Flats Area)

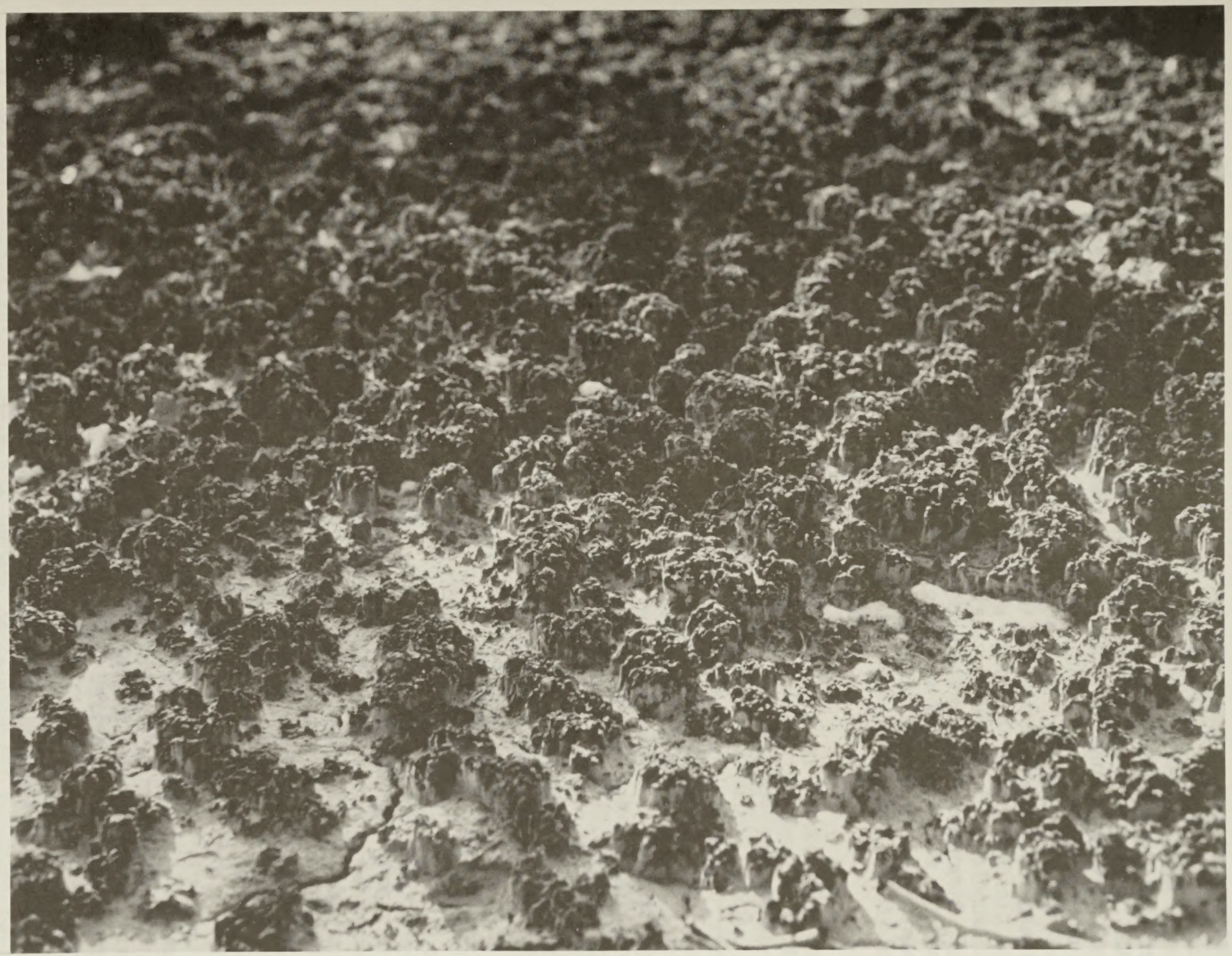


Fig. 29. Cryptogamic Crusts

VEGETATION

Vegetation distribution is primarily a function of soil moisture, slope, and aspect. The amount of soil moisture available during the growing season is the principal controlling factor, but slope and aspect also appear to have some influence.

Nine vegetation types occur in the lease unit and are summarized in table 11. These classes include badlands woodland, blackbrush shrubland, pinyon-juniper shrub/woodland (blackbrush zone), pinyon-juniper shrub/woodland (sagebrush zone), pinyon-juniper woodland, sagebrush shrubland, slickrock woodland, slope vegetation class, and canyon riparian. Detailed information on the vegetation communities is in appendix E; also see figure 55 for geographic distribution of these various vegetation types.

Table 13: Vegetation Types

Types	Acres
Badlands woodland	495
Blackbrush shrubland	3,470
Pinyon-juniper/woodland (blackbrush zone)	11,320
Pinyon-juniper/woodland (sagebrush zone)	4,895
Pinyon-juniper woodland	22,035
Sagebrush shrubland	2,740
Slickrock woodland	775
Slope vegetation class	4,110
Canyon riparian	26

The pinyon-juniper community is the most extensive vegetation type occurring within the proposed federal lease unit, covering some 22,035 acres. The pinyon-juniper community in the Orange Cliffs area is the best representation of this vegetation community within Glen Canyon National Recreation Area. Within this type, the density of the pinyon-juniper varies a great deal, as do typical understory species. Understory vegetation type and density is correlated to soil depth. Where the soil cover is nonexistent or very thin, the pinyon-juniper occurs with virtually no understory. Fremont barberry, Utah serviceberry, Bigelow sagebrush, and singleleaf ash occur as an understory, primarily on the mesa tops where there are pockets of soil within the bedrock outcrops. As soils deepen, the pinyon-juniper community supports a more diverse understory vegetation. Principal understory species include big sage, green ephedra, round-leafed buffaloberry, and other shrubs. Perennial forbs are more numerous, and bottlebrush squirreltail is the dominant grass.

The blackbrush shrubland type that covers 3,470 acres within the lease unit is most extensive on the undulating benches and flats of the canyons. There is generally a greater shrub species diversity within this vegetation type than the others. There are small, distinct soils and vegetation subtypes within

this community. Soils formed by weathering of the Chinle formation support a saltbush vegetation subtype, since the high clay and salt content of the soils gives a competitive advantage to salt-tolerant species, such as the saltbushes and salina wild rye that prefer clayey soils. The saltbush subtype also occurs in drainage bottoms, where soils with high clay content have been water deposited, and the species composition shifts more to grasses than at the higher elevation locales. Galleta, Indian ricegrass, and sand dropseed occur in greater density within the saltbush community on drainage bottoms, and there are fewer perennial forbs and shrubs than are found on similar soil types at higher elevations.

The big sagebrush vegetation type within the proposed federal lease unit (2,740 acres) is restricted to areas where there is a deep regolith, such as Gordon and Flint flats. Winterfat, rabbitbrush, and assorted shrubs are characteristic of this community. Blue grama and needle-and-thread are the dominant grasses.

Where the pinyon-juniper become sparser and the understory shrubs more dominant, the shrub-woodland vegetation type occur. Within the lease unit, this type has been subdivided into shrub/woodland (blackbrush zone) (11,320 acres) occurring mainly on the broad undulating benches within Happy Canyon, and shrub/woodland (sagebrush zone) (4,895 acres), occurring on the higher elevation mesa tops.

The slope type class occurs principally in areas where slopes are greater than 33 to 35 percent. The slopes directly below the Wingate formation are perhaps most distinctive examples of this type, where the soil generally has a higher clay content derived from the underlying Chinle formation. Shadscale and four-wing saltbush are common, along with Moenkopi poisonvetch, which appear to be restricted to this habitat type. The slope type class covers approximately 4,110 acres of the proposed lease unit.

A small area (775 acres) within the unit identified as slickrock woodland is sometimes classified as a distinctive type. Approximately 495 acres of badlands woodland has also been identified while, a very small 26-acre area of ephemeral riparian located in narrow-shaded canyon bottoms of the upper French Spring Fork of Happy Canyon is also present in the lease unit. The remaining 4,680 acres within the lease unit are principally barren rock cliffs and slopes.

Threatened or Endangered Vegetation Species

The U.S. Fish and Wildlife Service (FWS) has identified one federally listed threatened or endangered plant species and four species proposed for listing as potentially present within the proposed unit (USDI, FWS 1983). However, there are no documented occurrences of any of the five plants within the proposed unit.

Wright's fishhook cactus (Sclerocactus wrightiae L. Bensen) is a federally listed endangered species (Federal Register, June 16, 1976) known to occur in two locations in Wayne County, on shale formations. The Chinle formation that occurs on the lease unit is a bentonitic clay formation that could provide favorable habitat for the cactus.

Monument milkvetch (Astragalus monumentalis Barneby), under review for listing (Federal Register, December 15, 1980), occurs on the Cedar Mesa and Cutler formations in San Juan and Garfield counties. This pioneering species occupies crevices and sandy depressions in the pinyon-juniper and mixed desert shrub communities where other vegetation is sparse or absent.

Smith eriogonum (Eriogonum smithii Reveal), under review for listing (Federal Register, December 15, 1980), occurs only in Emery and Wayne counties between 4,500 and 5,500 feet in elevation. This large shrub appears to be restricted to the red selenium containing windblown sands of the San Rafael desert and occurs within the extreme northwestern corner of the proposed unit.

Drake scorpionweed (Phacelia indecora J.T. Howell), under review for listing (Federal Register, December 15, 1980), occurs only in Wayne and San Juan counties, on Mancos shale, clay, and basaltic soils associated with saltbush and blackbrush communities. This species may also occur on soils formed from the Chinle formation similar to those found on the proposed lease unit; this species is an annual adapted to rapid growth in years when moisture is adequate.

Jones cycladenia (Cycladenia humilas var. jonesii), under review for listing (Federal Register, December 15, 1980), is a small perennial herb originally known to exist only in one location in Grand County, Utah. Two other populations have since been found (USDI 1979). The closest population is more than 50 miles from the proposed federal lease unit. Jones cycladenia is found on a sandy, silty soil derived from the Cutler group and is associated with the desert shrub community at an elevation of approximately 5,000 feet.

WILDLIFE

Wildlife habitat types within the lease unit range from 26 acres of riparian valley habitat to pinyon-juniper woodland and sagebrush shrubland on the high flat plateaus. Although wildlife populations are not extensive within the area, the restrictive nature of the habitat makes those populations that do exist more sensitive to disruption. Appendix F lists the wildlife species that occur within the lease unit.

Desert bighorn sheep (see figure 30) are considered to be highly sensitive to man's activities and may be the most sensitive species in the area. Bighorn are not currently abundant in the vicinity of the proposed federal lease unit; an estimated total of 20 animals inhabit the three grazing allotments within and surrounding the proposed federal lease unit (USDI, BLM 1983). This estimate is based on reported sightings and physical evidence; no systematic census has been conducted. No sightings have been officially recorded within the proposed federal lease unit. Table 14 contains the recorded observations in the vicinity of the proposed federal lease unit.

The reasons for the existing low population level of bighorns in the area are not clear. It is unknown how high their previous numbers might have been, but low numbers such as those estimated for this area (20) are not generally

Fig. 30. Desert Bighorn, Southern Orange Cliffs Area

regarded as sufficient to maintain a viable population. Bighorn sheep are frequently depicted in prehistoric petroglyphs in the area, and they seem to be thriving on seemingly comparable habitat in Canyonlands National Park; the park has the fastest growing desert bighorn sheep population in the western United States (Loomis 1982).

Table 14: Recent Bighorn Sightings

Year	Location	Type of Sighting
1977	Horse Canyon, 1 mile above confluence with Green River	1 sheep
1977	Range Canyon, T31S, R17E, N1/2 sec. 33	1 sheep
1979	Overlook to Dirty Devil River (near Hanksville)	9 sheep
1981	Dirty Devil River, approximately 10 miles above confluence with Colorado River	6 sheep
1982	Bighorns transplanted to Maze district, Canyonlands National Park	26 sheep
1983	Elaterite Basin, just inside Canyonlands National Park boundary	1 sheep (ewe)

Source: Utah Division of Wildlife and Canyonlands National Park records.

In addition to adequate water, forage, and escape terrain, other critical habitat features include lambing, rutting, and ram summering areas. These have not yet been identified for the bighorn population in and around the lease unit, but the entire proposed federal lease unit is considered to be year-round range. Migratory behavior has not been documented here, but the bighorns are widely, although sparsely, distributed over the mesas, canyons, and plateaus of the area (USDI, NPS, DSC 1979). Canyon rims are identified as critical habitat to the extent that they are associated with access routes up and down the cliffs, or adjacent to areas of bighorn use below the rims.

The Utah Division of Wildlife Resources (UDWR), in cooperation with the NPS and the BLM, is managing bighorn sheep to restore them to their former range and to promote recovery in ranges with critically low population levels. The UDWR has identified the Orange Cliffs area as a transplant site for population recovery. Presumably, the habitat within the proposed lease unit could support numbers of desert bighorn similar to those found in Canyonlands National Park. In Canyonlands, the herd is maintaining a population of 300, even with the removal of 70 animals for transplant programs, over the last two years. One of the UDWR transplant areas (in 1982) was in the Maze district of Canyonlands National Park, immediately to the east of the proposed federal lease unit.

Bighorn sheep behavior varies from population to population. While some herds seem able to tolerate man and man's activities to a certain degree, the animals appear to go through a period of adjustment and traumatic stress before a measure of tolerance is gained. The extent of stress and the adjustment required for bighorns is not exactly known (Loomis 1982).

Rocky mountain mule deer are common inhabitants of the proposed lease unit, which is within the geographic locale of the UDWR herd unit no. 29. Little research has been done in the area, but the lease unit is not considered to be either crucial summer or winter mule deer range (USDI, BLM 1982a). Deer herd no. 29 census and hunting pressure information are presented in table 15.

Table 15: Deer Herd Harvest and Hunting Trends,
Deer Herd No. 29

Year	Hunters	Hunter's Residence	Buck	Antlerless
1973	476	Carbon County, 9% Emery County, 36% Salt Lake Co., 22% Utah County, 7% Other Utah co., 13% Nonresident, 13%	85	42
1974	496	Carbon County, 11% Emery County, 28% Salt Lake Co., 32% Utah County, 8% Other Utah co., 15% Nonresident, 6%	84	9
1975	396	Carbon County, 13% Emery County, 15% Salt Lake Co., 33% Utah County, 20% Other Utah co., 14% Nonresident, 5%	59	0
1976	724	Carbon County, 7% Emery County, 18% Salt Lake Co., 13% Utah County, 3% Other Utah co., 49% Nonresident, 10%	171	0
1977	574	Carbon County, 26% Emery County, 24% Salt Lake Co., 8% Utah County, 5% Other Utah co., 13% Nonresident, 24%	181	0

Year	Hunters	Hunter's Residence	Buck	Antlerless
1978	335	Carbon County, 16% Emery County 34% Salt Lake Co., 16% Utah County, 3% Other Utah co., 18% Nonresident, 13%	63	0
1979	295	Carbon County, 21% Emery County, 29% Salt Lake Co., 26% Utah County, 3% Other Utah co., 15% Nonresident, 6%	87	0
1980	378	Carbon County, 10% Emery County, 30% Salt Lake Co., 25% Utah County, 10% Other Utah co., 10% Nonresident, 15%	104	0
1981	336	Carbon County, 21% Emery County, 41% Salt Lake Co., 15% Utah County, 5% Other Utah co., 10% Nonresident, 7%	100	0
1982	117	Carbon County, 6% Emery County, 39% Salt Lake Co., 15% Utah County, 3% Other Utah co., 34% Nonresident, 3%	53	0

Source: UDWR records.

Pronghorn antelope inhabit portions of the northwestern corner of the proposed federal lease unit (see figure 31). Because much of the lease unit is covered with mature pinyon-juniper woodland, the unit generally provides only marginal habitat for antelope.

The proposed unit also lies within the geographic locale of the UDWR antelope herd unit no. 9 (see table 16 for census and hunting information). There are currently 31 animal unit months (AUM) allocated for antelope within the Robbers' Roost grazing allotment, but it is not known how many antelope actually inhabit the proposed unit. The most critical habitat is fawning grounds near water, and there is no such habitat within the proposed unit (USDI, BLM 1982a).

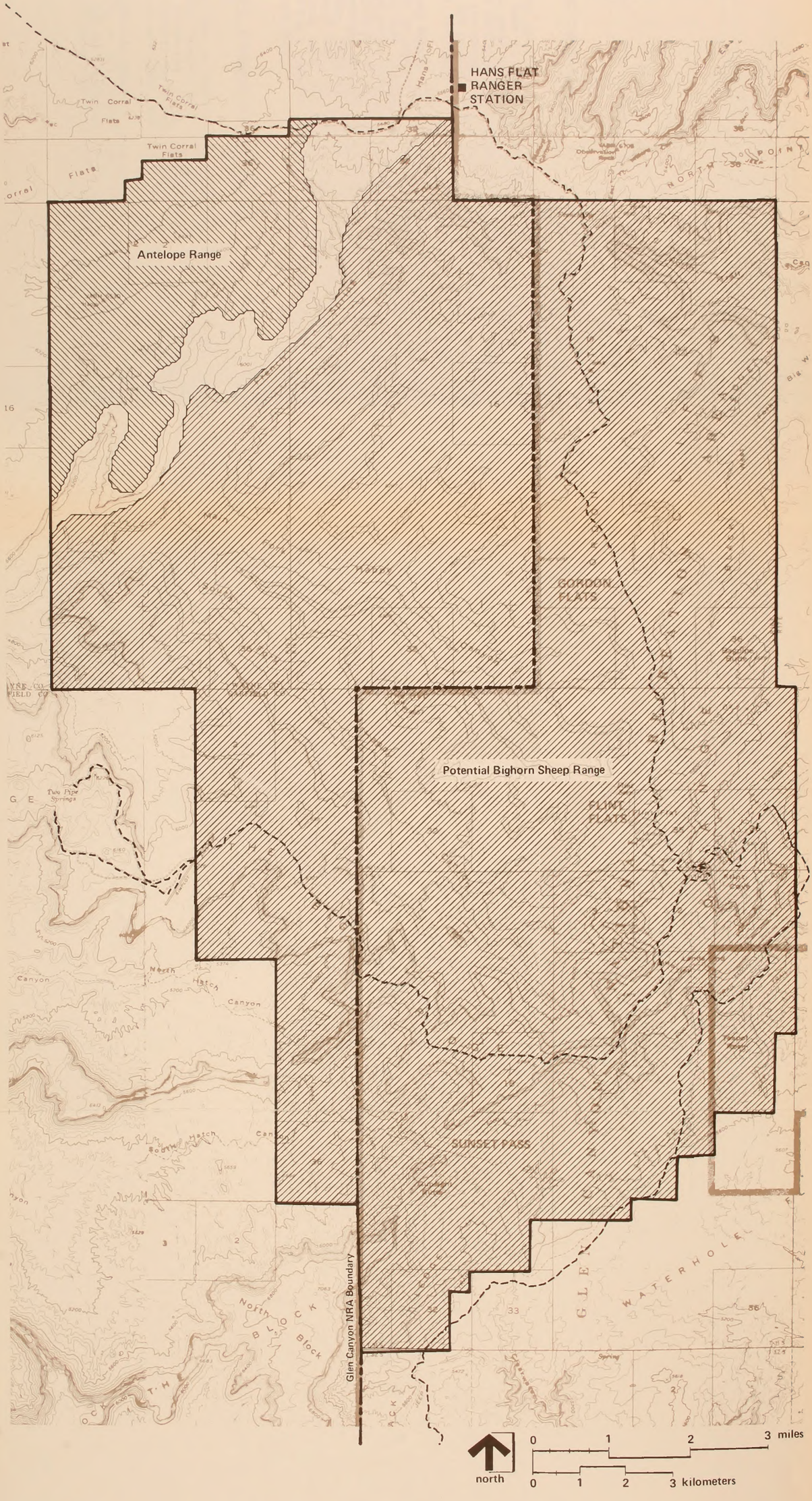


Fig. 31. Wildlife Range

TST	40020
DSC	NOV 83

Table 16: Antelope Herd Census and Harvest Trend
San Rafael Antelope Herd No. 9

Year	Total Aerial Count	Total Harvest (bucks only)
1974	48	3
1975	18	3
1976	103	6
1977	29	8
1978	5	5
1979	None observed	No hunt
1980	No count made	No hunt
1981	25	No hunt
1982	33	No hunt

Source: UDWR records.

Other large wildlife species found onsite include wild burros. Burros are sometimes seen in the northwestern sections of the proposed unit (see figure 31). This small herd occasionally uses Millard Canyon northeast of the lease unit. The herd tends to build up in numbers and then die back, presumably due to winter starvation. There are 100 animal unit months currently allocated for burros on BLM grazing allotments in the vicinity of the proposed federal lease unit (USDI, BLM 1982a).

The proposed federal lease unit has not been systematically surveyed for bird populations or species. Over 100 species of birds may inhabit or migrate through the area. Because the proposed federal lease unit is essentially arid, with few perennial water sources, there is almost no amphibian habitat onsite. Common amphibians of the region where aquatic habitats are available are the tiger salamander, western spadefoot toad, Rocky Mountain toad, plains toad, and leopard frog. Only the plains toad inhabits desert areas without year-round water sources (USDI, BLM 1976). Lizards and snakes are found in the proposed federal lease unit, but there has been no extensive survey performed (see appendix F for a listing of wildlife that occur in the vicinity of the proposed federal lease unit).

Threatened or Endangered Wildlife Species

There have been no sightings of threatened or endangered wildlife species in the proposed federal lease unit (USDI, FWS 1981). There are currently no federally designated critical habitats within the unit, but critical and high priority habitats for several federally listed endangered species exist near the proposed unit (USDI, BLM 1982b).

The two federally listed or state-protected mammal species that could occur in the vicinity of the federal lease unit are the blackfooted ferret (Mustela nigripes) and the Utah prairie dog (Cynomys parvidens). A 1981 survey found no evidence of either species within the proposed unit (Sigler and Associates

1982). Because of the shallow sandy soils and prevalence of slickrock areas in the vicinity of the federal lease unit, it is unlikely that either of these species could become established (Sigler and Associates 1982).

There are two federally listed and protected endangered bird species in the vicinity of the proposed federal lease unit--the bald eagle (Haliaeetus leucocephalus) and the peregrine falcon (Falco peregrinus). Bald eagles are winter residents and can be observed in the area from November through March (USDI, FWS 1983). The sandstone cliffs along the Colorado River near the lease unit are identified as high priority golden eagle and peregrine falcon habitat by the FWS and the state of Utah (USDI, FWS 1981; UDWR, DWR 1980a). The FWS conducted a raptor nest survey of the Tar Sand Triangle geographic area in 1982, and several active nest sites have been identified (see figure 15 in the "Alternative Including the Proposed Action" section). Active golden eagle nests were identified, but no active peregrine falcon eyries were confirmed along the Orange Cliffs. Peregrine nesting activity in the area is limited due to the arid environment and lack of an adequate prey base (USDI, FWS 1983; also see figure 31).

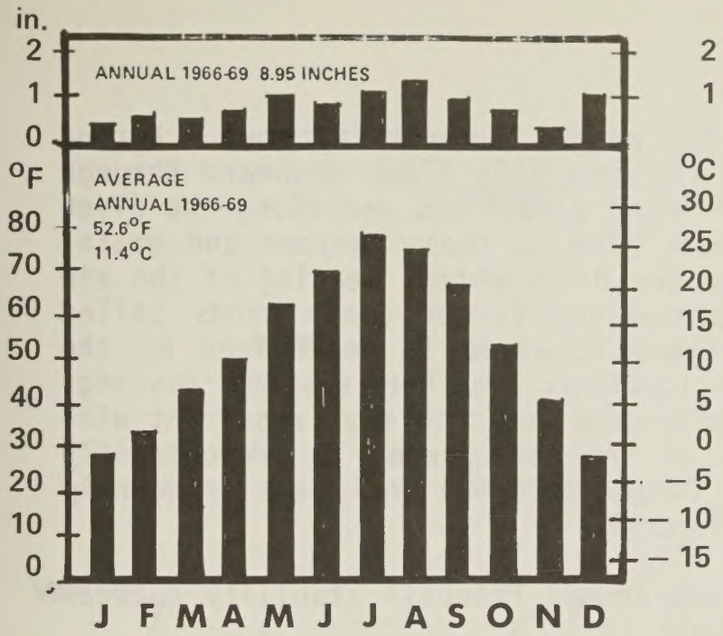
Colorado River system fish species identified by FWS that could be potentially affected by tar sand development include the razorback sucker (Xyrauchen texanus), the Colorado squawfish (Ptychocheilus lucius), and the humpback chub (Gila cypha). The razorback sucker is proposed for listing as a threatened or endangered species and inhabits the Dirty Devil River. The Colorado squawfish and the humpback chub, species that inhabit the Colorado River system downstream from the proposed federal lease unit, are both listed as threatened or endangered species.

AIR QUALITY

Meteorology and Climatology

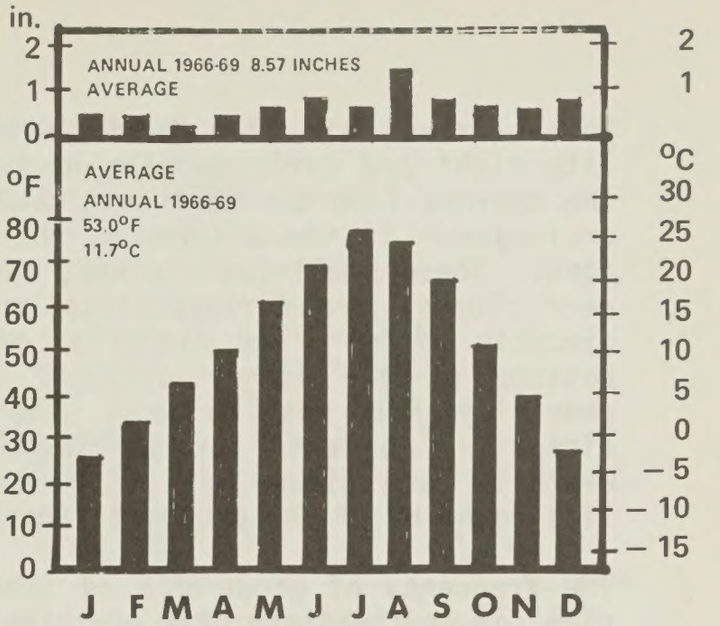
The climate of the area is semiarid. Localized temperature and precipitation data vary with elevation; the higher the elevation, the higher the average precipitation and the lower the average temperatures (see figure 32). The proposed upgrading facility would be located on the mesa top within the proposed federal lease unit, at an elevation of about 6,600 feet. Since site-specific temperature and precipitation data are not available, the values most analogous to those expected at the upgrading facility are those taken at the Hans Flat ranger station, however, the period of record is relatively short (about 2 years). Therefore, the temperature and precipitation data must be approximated from nearby stations with longer periods of record. Temperature variations at the site are probably best characterized by those at Monticello, which is at a similar elevation (6,950 feet). The summers are hot and dry, with maximum temperatures above 90°F. Winters are relatively dry and cold, with temperatures averaging 20° to 25°F. The temperature rarely drops below zero.

The precipitation amounts are expected to lie between those at Hanksville and Monticello. Therefore, annual precipitation should lie between 6.0 and 13.8 inches on the average, with the highest average monthly precipitation falling in July and August. The average annual snowfall is expected to be approximately 10 inches.



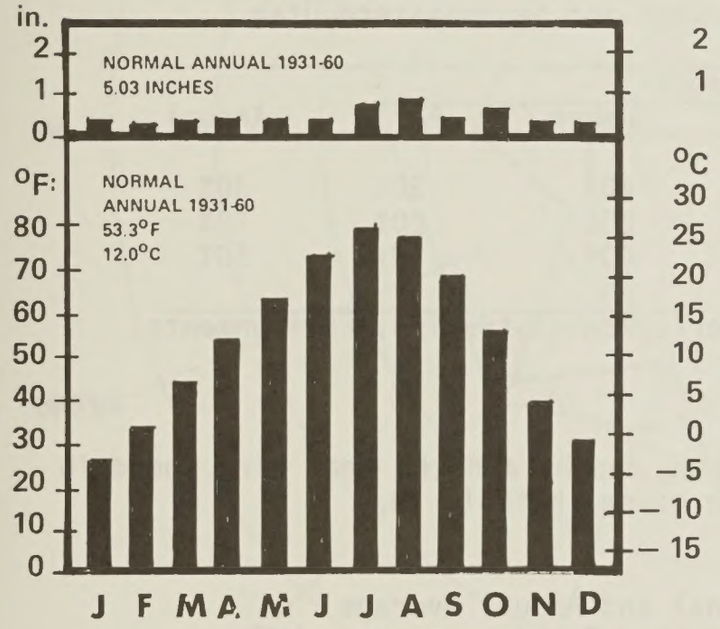
CANYONLANDS – THE NECK

ALTITUDE 5,900 FEET



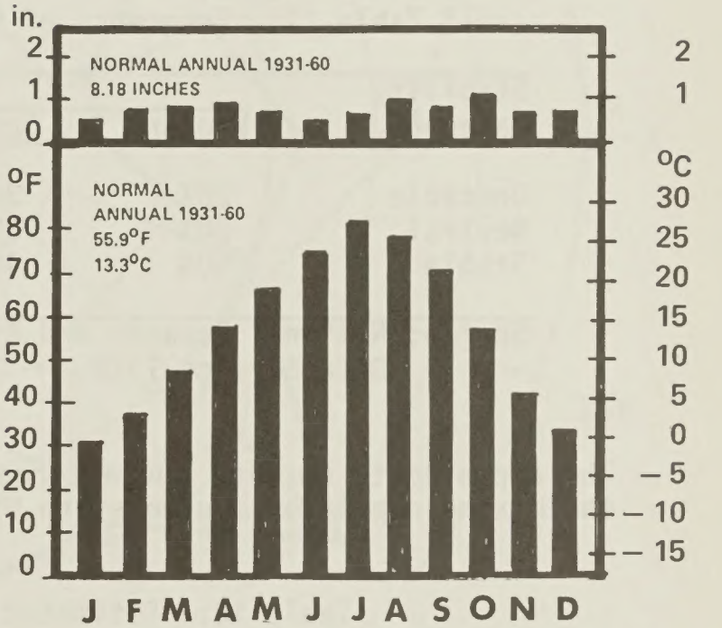
CANYONLANDS – THE NEEDLE

ALTITUDE 5,040 FEET



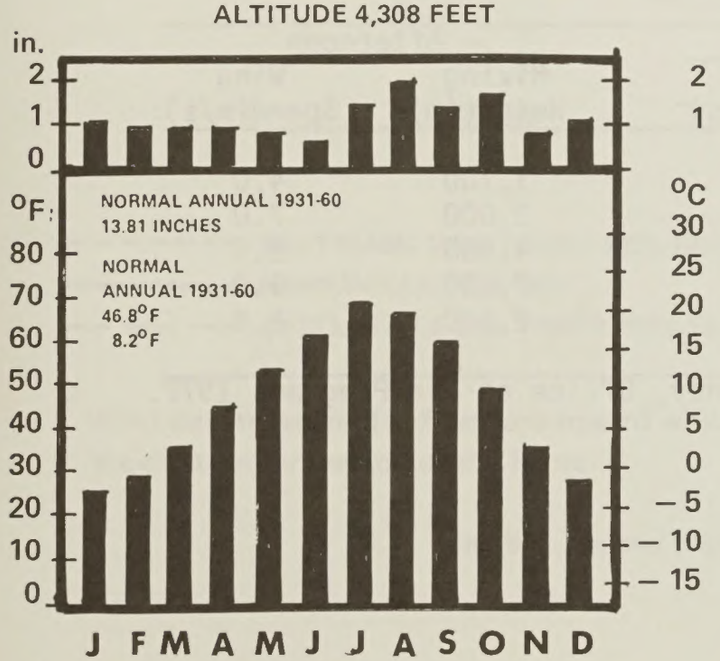
HANKSVILLE

ALTITUDE 4,308 FEET



MOAB 4 NW

ALTITUDE 3,965 FEET



MONTICELLO

ALTITUDE 6,950 FEET

Fig. 32. Temperature and Precipitation Data for Selected Southeastern Utah Locations

Local surface air flow is dominated by the rugged terrain features. During late night and early morning hours, the air generally flows downward through the canyons from the mesa tops toward the lower elevations and along the river drainages. In the afternoon, there is weak flow up these canyons and drainages. These small-scale winds, caused by the differential heating of the air near slopes, are perturbations on the prevailing larger scale winds called synoptic winds. The direction of the synoptic winds is determined by the passage of the larger cyclonic and anticyclonic weather systems passing, generally, from west to east. The available data indicate that resultant wind direction, at least for the lower 500 m of the atmosphere, is predominantly westerly (see figure 33). Consequently, Canyonlands National Park frequently lies downwind of the proposed federal lease unit.

The frequency of occurrence of seasonal and annual Pasquill stability categories for southeastern Utah are given in table 17.

Table 17: Frequency of Occurrences for Southeastern Utah

Stability Category	Seasons				
	Winter	Spring	Summer	Fall	Annual
Unstable	20%	30%	40%	30%	30%
Neutral	20%	30%	20%	20%	20%
Stable	60%	40%	40%	50%	50%

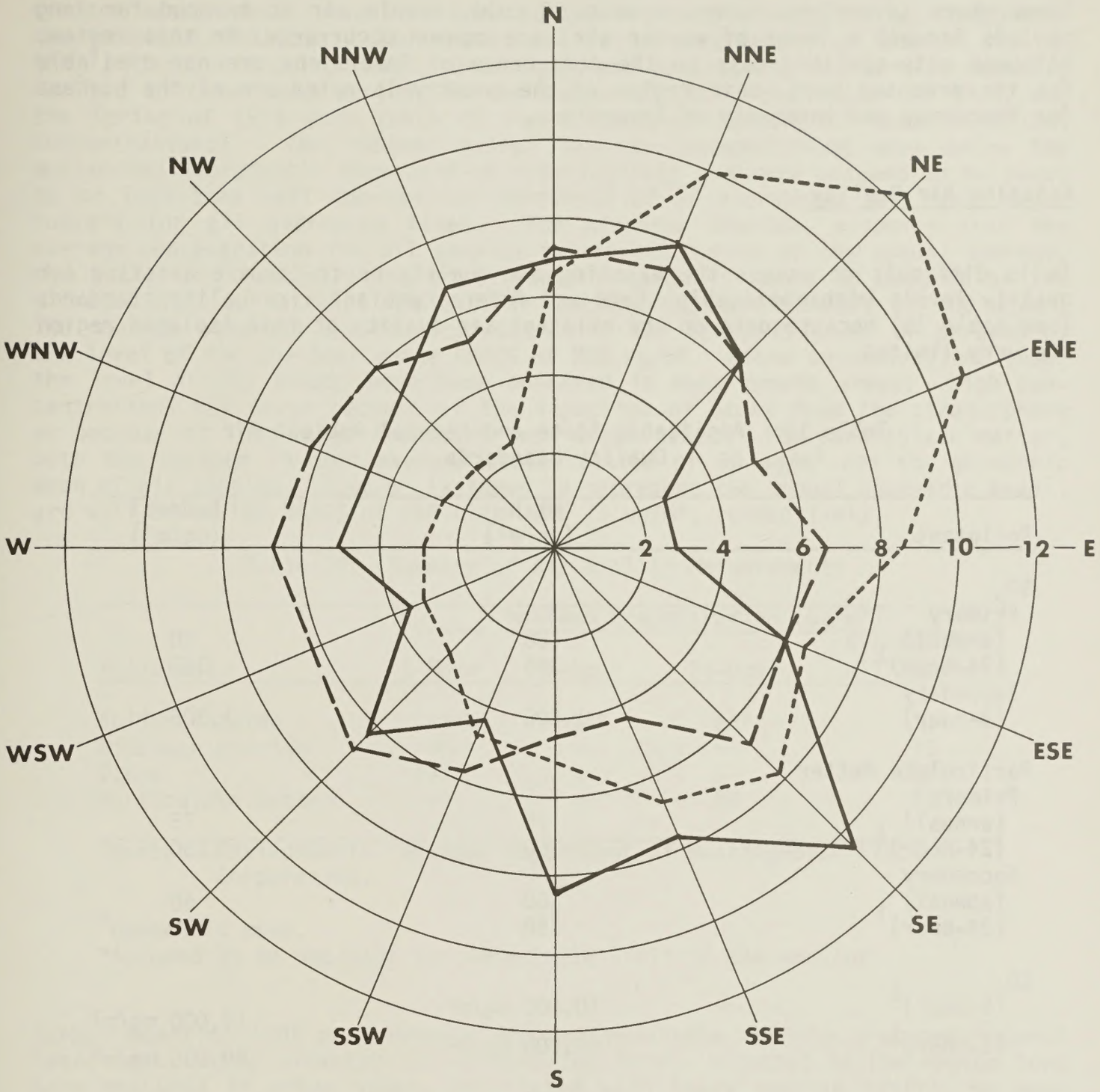
Source: National Oceanic and Atmospheric Administration, Environmental Data Service 1976.

The approximate morning and afternoon mixing depths and the mean wind speed in the mixing depth for southeastern Utah are given in table 18.

Table 18: Estimated Seasonal and Annual Average Mixing Depths and Wind Speeds

Season	Morning		Afternoon	
	Mixing Height(m)	Wind Speed(m/s)	Mixing Height(m)	Wind Speed(m/s)
Winter	250	3.0	1,100	4.0
Spring	400	5.0	3,000	7.0
Summer	250	4.0	4,000	6.5
Fall	250	3.5	2,200	5.0
Annual	300	4.0	2,600	6.0

Source: Environmental Protection Agency, Office of Air Programs 1972.



Wind directions are the directions toward which the sind is blowing; the frequency scale is shown at the right-center portion of the figure.

Fig. 33. Annual Wind Direction Distributions

Temperature inversions, where a mass of cold, stable air is trapped for long periods beneath a layer of warmer air, are common occurrences in this region. Although site-specific data on the occurrence of inversions are not available for the proposed unit, this region of the country is rated one of the highest for frequency and intensity of inversions.

Existing Air Quality

It is difficult to assess the existing air quality or to compare existing air quality levels with applicable state and federal ambient air quality standards (see table 19) because data on the existing air quality of this isolated region are very limited.

Table 19: Applicable State and Federal Ambient Air Quality Standards

Pollutant	Utah (ug/m^3)	Federal (ug/m^3)
SO_2		
Primary		
(annual)	80	80
(24-hour)[1]	365	365
Secondary		
(3-hour)	1,300	1,300
Particulate Matter		
Primary		
(annual)	75	75
(24-hour)[1]	260	260
Secondary		
(annual)	60	60
(24-hour)[1]	150	150
CO		
(8-hour)[1]	10,000 mg/m^3	10,000 mg/m^3
(1-hour)[1]	40,000 mg/m^3	40,000 mg/m^3
O_3		
(1-hour)[2]	235	235
NO_2		
(annual)	100	100
Lead		
(one-quarter of year)	1.5	1.5

[1] Not to be exceeded more than once per year.
[2] Expected number of days in a calendar year, with maximum hourly values above 235 ug/m^3 cannot exceed one.

Limited measurements have been made in the vicinity of Hanksville, Utah, near the proposed IPP power plant, and ambient concentrations of sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), and particulate matter were measured for two to three week periods in the summer of 1974, the winter of 1975, and the spring of 1976 (see table 20 for a seasonal summary of maximum ambient concentrations). The ambient sulfur dioxide concentrations were below the monitoring equipment's threshold of detectability and were assumed to be equal to or less than half the monitor threshold of 26 micrograms per cubic meter (ug/m^3) for all averaging times. For nitrogen dioxide, assuming that the average concentration for all samples is representative of the annual average, the background concentration of nitrogen dioxide is about 13 percent of the nitrogen dioxide National Ambient Air Quality Standard (NAAQS) of 100 ug/m^3. The maximum observed one-hour concentration for ozone is about 83 percent of the level of the one-hour ozone NAAQS of 235 ug/m^3. Ozone concentrations (near the level of the NAAQS) have been observed in many remote areas. High concentrations may occur because of the injection of ozone from the stratosphere or because of long-range transport from urban areas. For particulate matter, both the maximum 24-hour average concentration of 90 ug/m^3 and the geometric mean of all samples, 19 ug/m^3 (assumed to represent the annual geometric mean), are well below the NAAQS of 260 ug/m^3 and 75 ug/m^3, respectively.

Table 20: Summary of Air Quality Measurements

	Maximum Concentration (ug/m^3)			
Pollutant	1-Hour	3-Hour	24-Hour	Average of all Samples
Sulfur dioxide	13*	13*	13*	13*
Nitrogen dioxide	40	--	--	13
Ozone	132	--	--	59
Particulate matter	--	--	90	19[a]

Source: Environmental Systems Department of Westinghouse Electric Corporation.

[a]Geometric mean.
*Assumed to be one-half the detectable limit of the monitor.

Carbon monoxide (CO) measurements are not available for the proposed federal lease unit. Only elevated carbon monoxide levels detected in the region have been measured in urban areas, associated with heavy vehicle traffic or near industrial development. Carbon monoxide levels in the lease unit are probably at or near the monitoring threshold, or about 10 percent of the one-hour NAAQS of 40 ug/m^3.

Another program mandated by the Clean Air Act is prevention of significant air quality deterioration (PSD). PSD is a program developed to protect areas with air quality cleaner than the NAAQS. Such clean areas are designated under any of three classes. Each classification differs in the amount of growth it will permit before significant air quality deterioration would be deemed to occur. The proposed federal lease unit (both NPS and BLM lands) is designated class II. Near the unit, Canyonlands, Arches, and Capitol Reef national parks are

all designated class I. Significant deterioration occurs when the amount of new pollution would exceed the applicable maximum allowed increases (increments), the amount of which varies with the classification of the area (see table 21).

Table 21: Prevention of Significant Deterioration Increments

Pollutant	Averaging Time	Maximum Allowable Concentrations (ug/m^3) Class I	Class II	Class III
sulfur dioxide	Annual	2	20	40
	24-hr	5	91	182
	3-hr	25	512	700
Particulate matter	Annual	5	19	37
	24-hr	10	37	75

Visibility is an important air quality related value in Glen Canyon National Recreation Area and Canyonlands National Park. In the canyon country of southeastern Utah, the quality of the recreational experience depends upon the grand scale of the topography and the dramatic vistas perceived by the persons who visit the area. The proposed federal lease unit lies within a region of the United States noted for high yearly average visibility (see figure 34).

Although visibility measurements have not been made onsite, data from Canyonlands National Park, Glen Canyon National Recreation Area, and Capitol Reef National Park indicate visual range averages 180 to 190 kilometers or more at least 50 percent of the time. Visual range averages less than 100 kilometers only 10 percent of the time.

NOISE

Specific measurements for noise have not been taken within the proposed federal lease unit. Sound levels are a measurement of sound approximating the auditory sensitivity of the human ear. Typical daytime ambient noise levels for rural, undeveloped areas such as the proposed unit, range from 16 to 35 decibels, A-weighted (dbA) (USEPA 1974). In the qualitative sense, noise levels in this range are very quiet to quiet. Existing sources of noise could include vehicular traffic; small pumps, generators, and similar equipment associated with private or federal agency residences and developments; airplane noise; and natural noise stemming from wind and water movement and other such naturally occurring phenomena (see appendix G for a discussion of typical noise levels and receptor sensitivities). Also see the discussions on "Recreation and Wilderness Values."

The community of Green River (north of the proposed federal lease unit) is currently experiencing noise (estimated at 86 dbA at 50 feet) from heavy truck traffic on I-70, a major east-west route connecting Denver with southern California metropolitan areas.

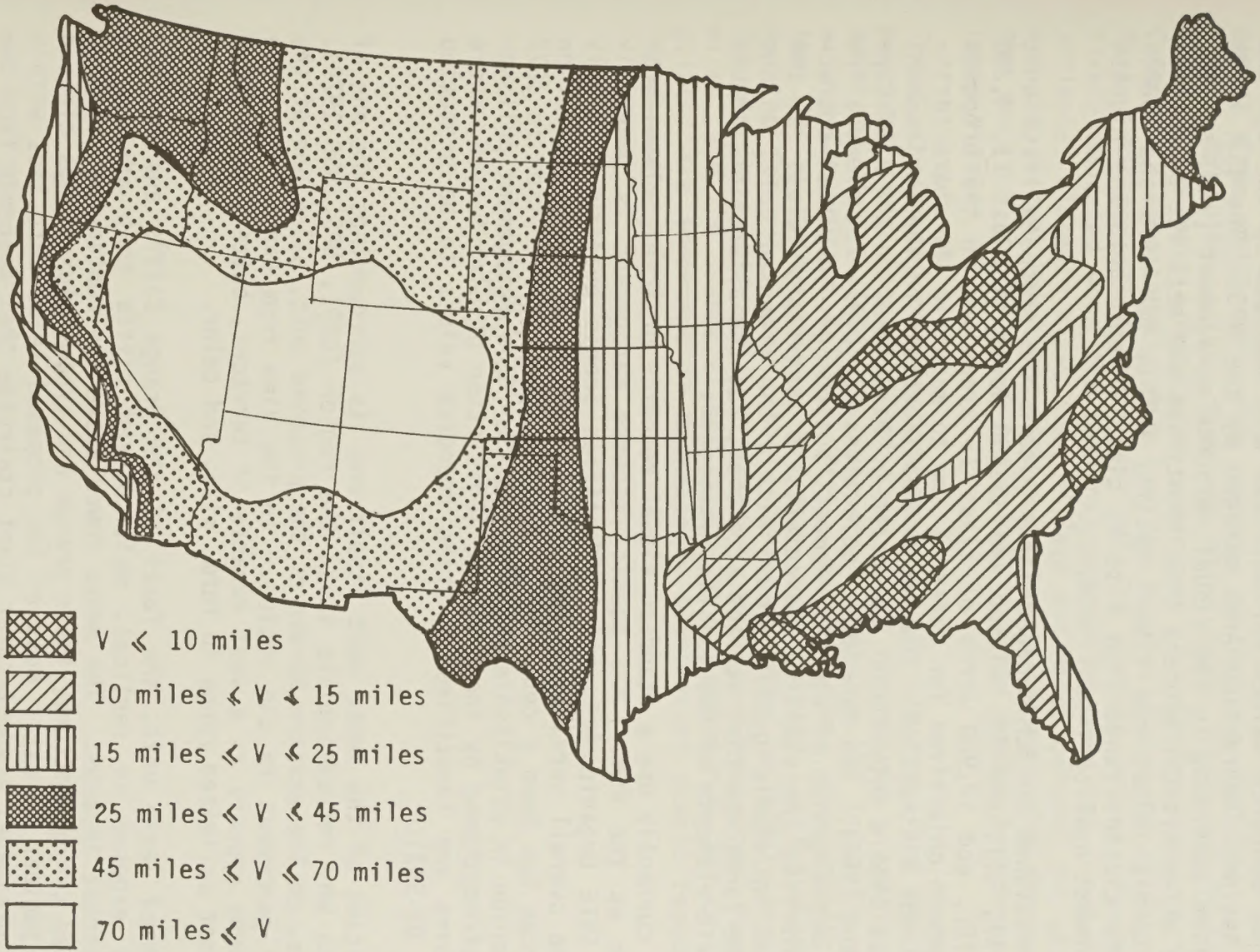


Fig. 34. Visual Range for the Continental United States
(yearly average visibilities, compiled March 1980)

TST	40022
DSC	NOV 83

SCENIC QUALITY

The scenic resources of the proposed federal lease unit and its surroundings are an important feature of the environment. Visual and scenic quality are identified as prime resource values for both the WSAs managed by the BLM and for Glen Canyon National Recreation Area managed by the NPS. The BLM lands have been classified according to the visual resource management (VRM) system. The VRM system is an analytical process that identifies and sets the objectives for maintaining scenic values and visual quality (USDI, BLM 1978 and 1980). The visual quality classes range from I to V; class I represents the highest and class V the lowest quality visual resource.

The VRM classes assigned to BLM-managed lands within the proposed lease unit include classes II, III, and IV. There are 15,560 acres of class II, 4,260 acres of class III, and 10,960 acres of class IV areas within the proposed unit. The management objectives for class II are to maintain the characteristic landscape without distraction. Changes or modifications to the environment can be visible but should not attract attention or be evident on the landscape (USDI, BLM 1978 and 1980). The management objectives for class III areas allow some perceptible modification of the environment, but changes in visual character should not override the existing characteristic landscape. Class IV, the lowest rated area in scenic quality found within the proposed unit, allows alterations to the landscape that attract attention, but the alterations should duplicate the basic elements of the existing landscape.

The NPS does not currently use a standard visual resource or scenic classification system such as the VRM. NPS scenic resource management is generally founded on the 1916 Organic Act, which identifies scenic quality as highly significant. The overall servicewide goal of identification and preservation of scenic resources has been a central NPS concern since its creation in 1872 and a prime criterion in establishing national parks. This management philosophy is further strengthened by the enabling legislation of Glen Canyon, where the scenic features are identified as prime resource values to be protected unimpaired (P.L. 92-593).

The scenic qualities of the lease unit itself and its surroundings are one of the major reasons why recreationists visit the region (USDI, NPS, DSC 1979). The Orange Cliffs, on the eastern border of the proposed unit, allow one of the most spectacular panoramas in the region. In the view from Canyonlands, the Orange Cliffs scene appears as a vast expanse of terraces, buttes, mesas, and cliffs, with almost unlimited range in form, size, and color.

Within the proposed lease unit, the faces of the Orange Cliffs and the Big Ridge are fully exposed in vertical, multicolored cliffs that advance in headlands and retreat in bays. The mesas tower above the contiguous lowlands and deeply incised canyon bottoms, their orange and cream-colored tops clothed in green pinyon-juniper forest. Most of the proposed lease unit lies within the Happy Canyon drainage, a spectacular giant staircase that descends from the mesa tops to the center of the canyon. There are several levels, each a platform or terrace of irregular width, that rise one above the other in precipitous steps hundreds of feet in height. The facades of the cliffs

separating the terrace levels are majestic walls or murals that form dramatic visual features. In some areas of the unit, erosional forces have resulted in detached and sculptured buttes, monuments, and minarets such as Gunsight Butte, Teapot Rock, and the Hat.

Overlooks from atop the Big Ridge and Orange Cliffs provide several vantage points from which this wide variety of terrain features can be viewed (see figure 35). Accessible from the Flint Trail, these overlooks allow views of some of the most spectacular panoramas of tributary canyons to the Green and Colorado rivers and the Maze and the Needles districts of Canyonlands National Park. Management of these overlooks to protect scenic resources was legislatively mandated when the national recreation area was created in 1972. More intimate, close-in views down Millard and Happy canyons are also breathtaking, and the distant LaSal and Blue mountains to the east and the Henry Mountains to the west of the proposed lease unit provide scenic backdrops to the shorter range views.

The flat pinyon-juniper topped mesas of the Big Ridge and the Orange Cliffs, a pleasant green open woodland aspect, are themselves a scenic resource of the area and play an important role in maintaining the integrity of the viewsheds within Canyonlands National Park. Viewed from a distance (as from Island in the Sky in Canyonlands), the study area (Orange Cliffs) forms a distinctive horizon for views across the intervening miles of highly variegated terrain. The clarity of the air in the region commonly allows visual ranges of 50 to 100 miles, and the Orange Cliffs (about 20 air miles from Island in the Sky viewpoints) are important in maintaining significant scenic resources of Canyonlands National Park.

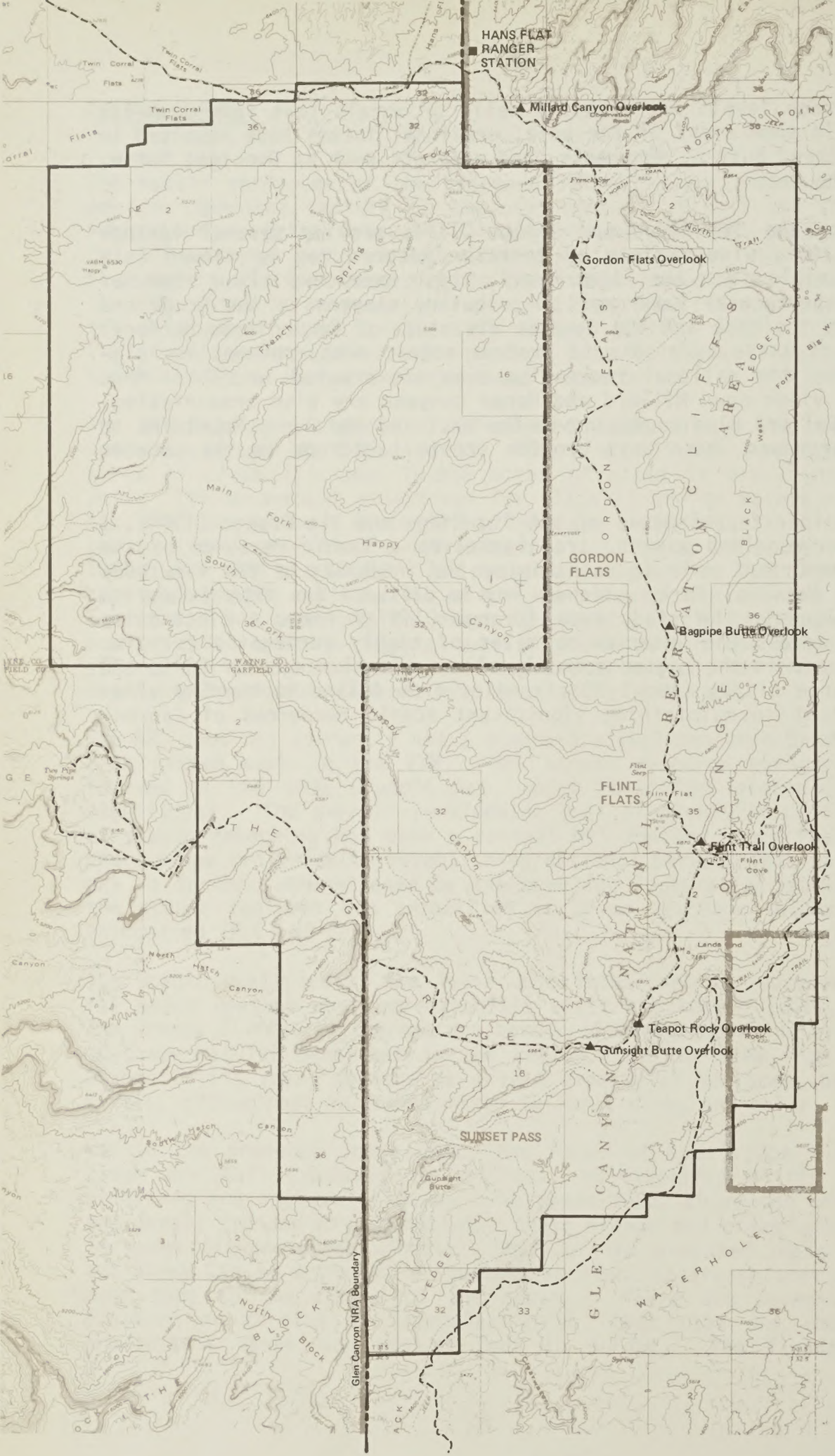


Fig. 35. Major Overlooks Along Orange Cliffs, Glen Canyon National Recreation Area

CULTURAL RESOURCES

HISTORY

Historical themes for the area are ranching, uranium exploration, and early oil and gas exploration. Little information exists on the historic resources that may be present in the proposed federal lease unit. No comprehensive historic resources survey of the area has been done, but archeological surveys have not identified significant historic period remains.

A group of structures in the Flint Flat area is referred to locally as the Wolverton cabin. Minimal research has been unable to establish whether Wolverton, a figure of regional historical importance, actually built the cabin, or, indeed, what his connection was with the site. The cabin is probably early 20th century, and the cabin site typifies pioneering ranching days in the region. The use of the cabin and exact dates of its construction have not yet been established. Portions of a log cabin (two rooms) and a small stone structure are still present. Although little is currently known about the Wolverton cabin, the cabin and its setting are of local significance and interest to visitors to the Hans Flat area as an example of the rigors of life in an earlier time. The eligibility of the cabin and its surroundings for inclusion on the National Register of Historic Places has not been determined.

ARCHEOLOGY

The Tar Sand Triangle geographic area has received several project-specific archeological surveys pursuant to legislative mandates and agency historic preservation policies (USDI, NPS, MWAC 1973 and 1975; USDI, NPS, RMR 1979; Copeland 1980; USDI, BLM 1977; Nickens 1981; Reed 1981). Two larger scale sampling-based surveys conducted specifically for tar sand leasing and development projects are underway. Survey work has not been completed, but a total of 290 archeological sites within the Tar Sand Triangle Special Tar Sand Area (STSA) have been recorded as of May 30, 1983.

A total of 140 sites documented to date are within the proposed unit (see figure 36), and another 27 sites are along the access road from UT 24 into the unit. Approximately 7 percent of the lands within the proposed federal lease unit have been surveyed, 9 percent of lands managed by the NPS and 5 percent of lands managed by the BLM (see figure 37). All road corridors (existing roads and corridors proposed as a part of other activities in the area) surveyed in the past produced large numbers of archeological sites, and all wellpad surveys, including review of pads constructed during the 1950s, have yielded archeological sites. An overall density of 24 sites per square mile is estimated for the proposed federal lease unit. Average site density on NRA lands, much of which are pinyon-juniper uplands, is 34 sites per square mile, and some areas have yielded a density as high as 58 sites per square mile. All data suggest that there are many more sites within the proposed federal lease unit. It is hypothesized from existing site density data that the proposed unit contains a minimum of 2,000 archeological sites.

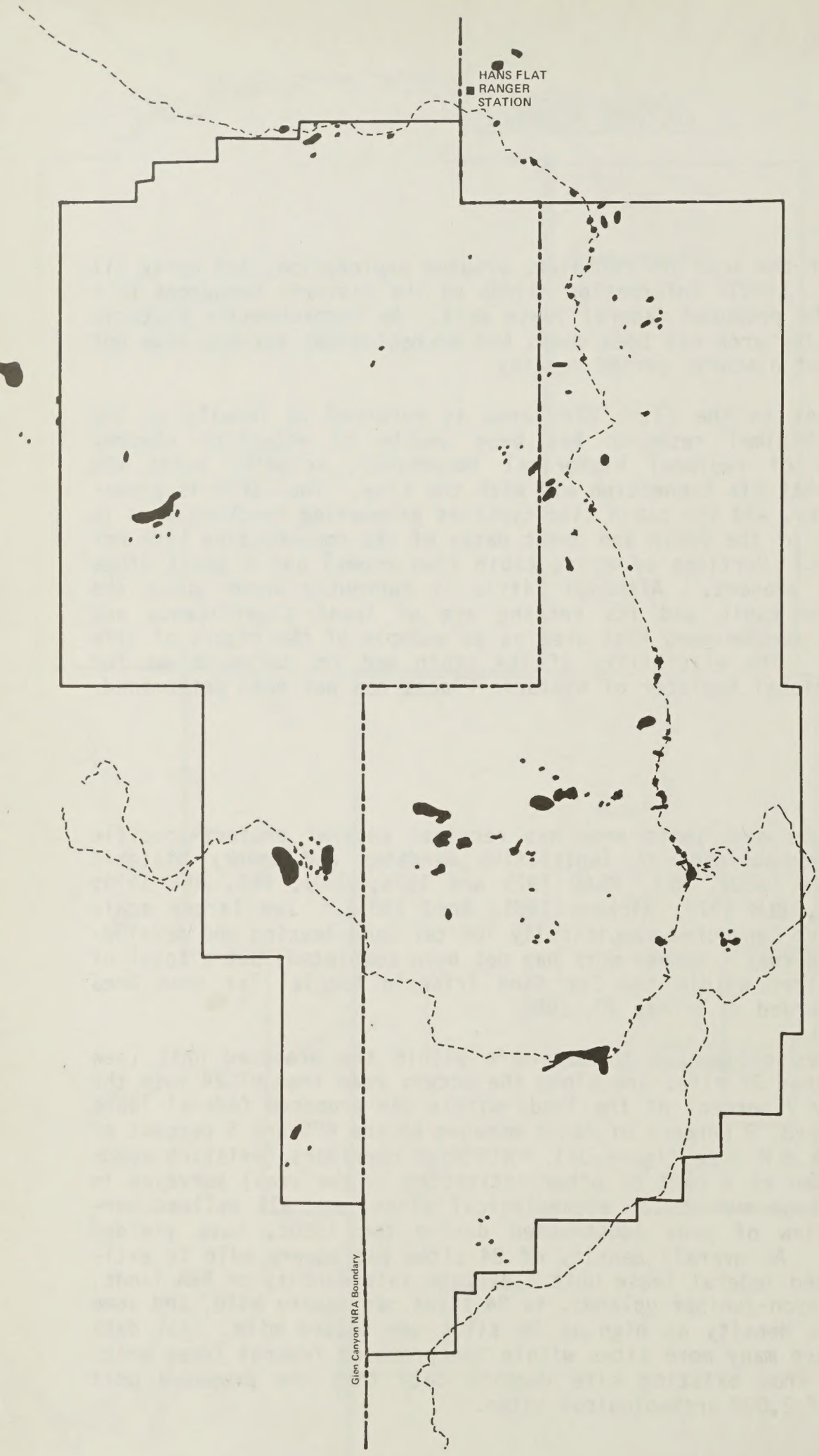


Fig. 36. Recorded Archeological Sites

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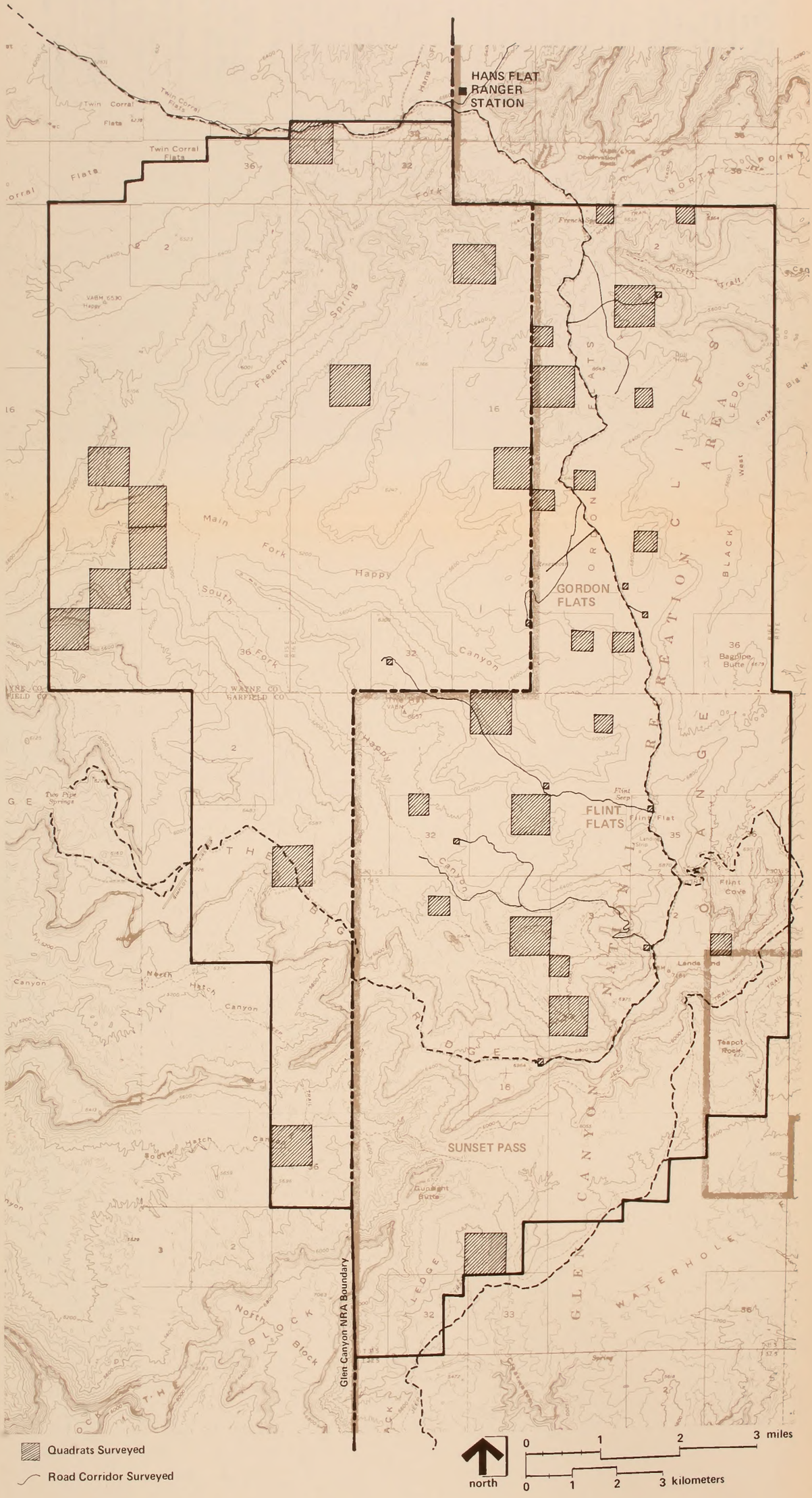

Fig. 37. Areas Surveyed for Archeological Resources

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Archeological sites in the proposed unit include (1) extensive quarries over an acre in size that occur in canyon bottoms; (2) stone tool manufacturing sites; (3) rock art sites; (4) large shallow temporary base campsites containing numerous hearths; (5) rock shelters with evidence of considerable depth; and (6) tool manufacturing and transient campsites. The majority of these sites stem from the Archaic Tradition, a highly mobile lifestyle based on hunting and gathering, which dates from approximately 8,000 years ago to the historic period in this area. There is also evidence, although limited, of probable Anasazi agriculturists' use of the uplands and of Numic (prehistoric Ute) occupation of the area.

Sixteen of the sites within the proposed federal lease unit have been recommended for nomination to the National Register of Historic Places on an individual basis. However, a determination of eligibility is being sought for an Orange Cliffs Multi-Resource National Register nomination, which designates several districts and the 16 sites. The proposed districts are Flint Seep/South Fork Happy Canyon, French Spring, Gordon Flats, Happy Canyon, Big Ridge, and two isolated concentrations of sites. The proposed multi-resource area is significant because the numerous, pristine sites within the complex create a picture of prehistoric occupation and use of the region during the Archaic time period that, under present levels of knowledge, is not duplicated anywhere else on the Colorado Plateau. The presence of such a variety of high quality archeological sites provides an opportunity for research into many aspects of prehistoric settlement patterns, material culture, lithic technology, cultural affiliation, and other aspects of prehistoric life.

In addition to sites within the proposed unit, there are numerous significant sites--sites listed on the National Register of Historic Places--near the proposed federal lease unit. Horseshoe Canyon, a detached unit of Canyonlands National Park north of the proposed unit (and accessible from one of the applicants' proposed access routes into the unit), contains some of the most spectacular and unique pictographs and petroglyphs in North America (see figure 38). This is the type locale of the Barrier Canyon style rock art, which has been dated as early as 3,000 years ago. The rock art is the oldest dated rock art in North America. The sites include a number of extensive panels of intricately decorated anthropomorphic pictographs over 6 feet in height. There are also Barrier Canyon style rock art sites (also on the National Register) nearby, in the Maze district of Canyonlands.

An archeological survey in the Maze district canyons immediately east of the proposed unit recorded 248 sites, including spectacular rock art sites (Lucius 1976). Most of these latter sites present a contrast to the Archaic period sites within the proposed federal lease unit.

The canyons immediately north of the proposed unit also contain a number of major rock art sites including the Cowboy Caves, which are the major and most important Archaic period stratified sites in southeastern Utah. Ongoing archeological surveys have revealed areas of extremely dense prehistoric occupation to the south and west of the proposed unit. For example, a quarter-section quadrat contiguous with the proposed southern boundary of the unit yielded 18 archeological sites (a density of 72 sites per square mile). The area immediately east of the Orange Cliffs has never been surveyed for archeological remains, but because the area is surrounded by remains indicating dense prehistoric occupations it is reasonable to assume that it, too, contains a large number of sites.

Fig. 38. Photo of Pictographs

SOCIOECONOMIC ENVIRONMENT

The information contained in this section is summarized from the "Socioeconomic Technical Report: Tar Sand Triangle Special Tar Sand Area Development Analysis" (Argonne National Laboratory 1983). The area considered includes primarily Emery and Wayne counties in Utah and the incorporated communities of Green River and Hanksville. Proposed development in the Tar Sand Triangle is also likely to influence, but to a lesser extent, the socioeconomic characteristics of Garfield County and the Hite and Bullfrog developed areas within Glen Canyon National Recreation Area.

REGIONAL SOCIOECONOMIC SETTING

The people of Emery and Wayne counties are economically dependent upon access to and use of natural resources in and near the proposed federal lease unit. The livestock industry and management of livestock forage has traditionally been a major element in the economy. Many livestock owners also have other jobs, since livestock operations often do not offer a sufficient source of income. Mining is also an important area for employment opportunity. Although uranium mining has been regionally important in the past, the uranium industry is currently depressed. Oil and gas development has not been a major part of the baseline economy of the region, although moderately intense exploration activity has occurred in the past. Backcountry outfitting, recreational services, and tourism are also significant elements in the area's economy, particularly for the community of Green River and the developments at Hite and Bullfrog.

POPULATION AND EMPLOYMENT

Population

In 1980, the total population of Emery and Wayne counties was 13,452; 9.7 percent reside in the communities of Green River (Emery County) and Hanksville (Wayne County). The age distribution within the two counties is similar. Of the 11,451 population (1980) in Emery County, 23.4 percent were of school age, 53.3 percent of work age, and 6.7 percent of retirement age; of the 1,911 population (1980) in Wayne County, 22.0 percent were of school age, 51.4 percent were of working age, and 13.6 percent were of retirement age. Future population projections without proposed tar sand development indicate that the area would grow slowly, with Green River growing more rapidly in the present decade (1980-90) than in the next (1990-2000). The population of Hanksville is projected to decline by 4 percent between 1980 and 1985 and then climb steadily through the year 2000. The population trends are as follows:

Community	1980	1990	2000
Green River	956	1,100	1,200
Hanksville	351	430	522

Employment

A total of 6,220 people were employed in both Emery and Wayne counties. Of the two counties, Emery had the larger share of jobs (88 percent of the total). Future employment increases without proposed tar sand development would be greatest for Emery County during the period from 1985 to 1990, while Wayne County would experience very slow growth through the year 2000 (see table 22 for baseline employment projections).

Personal Income

The baseline personal income projections present the average per capita personal income (PCPI) for the two-county area (1980 dollars). Green River had the highest PCPI, Hanksville the lowest. The following future baseline projections indicate a general trend of slow growth in PCPI for Green River, with a slightly smaller projected increase for Hanksville:

Geographic Area	1985	1990	1995	2000	2005
Emery County	8,932	9,736	10,631	11,568	12,858
Wayne County	7,146	7,789	8,505	9,254	10,068

Housing

Based on 1980 U.S. Census data, 65 percent of the dwelling units within Emery County are single family, 30 percent are mobile homes, and the remaining 5 percent are multifamily structures. In Wayne County, 85 percent of the dwelling units are single family, 13 percent are mobile homes, and 3 percent are multifamily structures. Temporary housing in mobile homes has not been an important part of the housing picture in the past in either Green River or Hanksville. Currently, vacancy rates for dwelling units in Emery County are running at about 10.5 percent, and at approximately twice that rate in Wayne County. Owner-occupancy rates are 81 percent for both counties, and the average value of owner-occupied units is $50,000 for Emery County and $42,000 for Wayne County. Housing demand without proposed tar sand development could increase for Hanksville but decrease for Green River (see table 23 for housing demand projections).

GOVERNMENT SERVICES AND FACILITIES

Education

Total enrollment in Emery and Wayne county schools for 1982 was 3,836 students (grades K-12). With a combined capacity of 4,939 students, the schools in the

Table 22: Baseline Employment Projections by Industrial Sector
1985-2005

Industry Sector	Emery County					Wayne County				
	1984	1990	1995	2000	2005	1985	1990	1995	2000	2005
Agriculture	360	360	360	370	370	170	170	170	170	170
Mining	2,460	2,500	2,500	2,500	2,500	30	30	40	50	50
Contract construction	850	440	470	480	500	130	140	160	190	210
Manufacturing	40	50	50	50	50	30	40	40	40	50
Transportation, communication, utilities	720	820	840	860	880	2	2	3	3	3
Wholesale and retail trade	630	370	700	700	730	40	60	60	70	80
Finance, insurance, real estate	60	60	70	70	70	20	20	20	20	20
Services	340	380	400	430	450	30	30	30	30	30
Government	770	840	840	810	800	290	330	360	390	430
Nonfarm proprietors	500	530	540	530	530	210	210	250	280	300
Totals	6,730	6,650	6,770	6,800	6,880	960	1,050	1,130	1,240	1,360

Source: Utah State Planning Coordinators Office, UPED Model Output (June 1983).
Note: Totals may not add due to rounding.

Table 23: Baseline Housing Demand Projections by County and Community
1985-2005

County/Community	Change in Housing Demand, by Year and Type														
	1985			1990			1995			2000			2005		
	Single Family	Multi-Family	Mobile Homes	Single Family	Multi-Family	Mobile Homes	Single Family	Multi-Family	Mobile Homes	Single Family	Multi-Family	Mobile Homes	Single Family	Multi-Family	Mobile Homes
Emery County	376	94	157	455	114	190	468	117	195	434	109	181	414	104	173
Castle Dale-Huntington Census County Divisions	144	36	60	227	57	95	237	60	99	206	52	86	191	48	80
Castle Dale	114	29	48	149	37	62	160	40	67	151	38	63	147	37	61
Cleveland	6	2	3	11	3	5	11	3	5	9	3	4	9	3	4
Elmo	6	2	3	9	3	4	9	3	4	8	2	4	8	2	3
Huntington	48	12	20	60	15	25	55	14	23	46	12	19	42	11	18
Orangeville	88	22	37	104	26	43	106	27	44	100	25	42	97	25	41
Emery-Ferron Census County Division	76	19	32	45	12	19	50	13	21	42	11	18	38	10	16
Emery	9	3	4	5	2	2	6	2	3	6	2	3	5	2	2
Ferron	87	22	37	68	17	29	73	19	31	70	18	29	67	17	28
Green River Census County Division	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Green River	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wayne County	39	10	16	81	21	34	126	32	53	159	40	67	195	49	81
Hanksville Census County Division	15	4	7	26	7	11	35	9	15	44	11	18	52	13	22

*Population projections indicate a decline in future population levels; existing housing units would become available in the future.

two counties were operating at slightly over 77 percent capacity. However, the two elementary schools closest to the proposed unit--Green River and Hanksville--are already operating at capacity, with 161 and 52 students, respectively (see table 24 for present school enrollment information). Projected baseline growth in educational needs are presented in table 25.

Bonding capacity for the two school districts appears to be good. Emery County recently completed a building program that doubled the capacity of the schools. Over $30 million in bonding capacity remains; the state estimates that Emery County would need to spend $18 million or more by 1987 to accommodate baseline growth. Wayne County has $3.3 million available for school improvements over the next three years, with an estimated $730,000 needed to accommodate baseline growth to 1987.

Law Enforcement

The Emery County sheriff currently has a 34-member department, including dispatchers and jailers. The county jail facility is located in Castle Dale, about 60 miles northwest of Green River, and can handle 10 prisoners. This facility cannot currently accommodate female or juvenile prisoners. Green River maintains its own two-officer police force, supplemented by five Utah State Highway Patrol officers and two Emery County deputy sheriffs stationed in Green River.

Wayne County maintains a sheriff's department located principally in the western portion of the county. Hanksville currently has one part-time deputy sheriff and one Utah State Highway Patrol officer stationed there. Emergency response time from Loa (the county seat) to Hanksville is approximately one hour by road for additional law enforcement backup.

On lands within Glen Canyon National Recreation Area, law enforcement is shared between the county sheriff departments and the NPS. There are currently two permanent NPS employees stationed at the Hans Flat ranger station, located in the Orange Cliffs area adjacent to the proposed federal lease unit; only one employee is a commissioned federal law enforcement officer. The nearest backup law enforcement ranger is stationed at Hite Marina, over three vehicle hours away. The Hans Flat and Hite Marina law enforcement rangers are also special deputy sheriffs for Wayne and Garfield counties. Normally, park rangers have petty offenses and federal felony jurisdiction, and the county sheriff is responsible for state felonies. Response time from Hanksville to the proposed federal lease unit is 90 minutes or more, depending upon road and weather conditions. Table 26 contains projected baseline changes in public safety requirements including law enforcement.

Fire Protection

Both counties operate volunteer fire departments. Green River and Hanksville maintain pumper trucks and limited rescue equipment, and the BLM provides limited fire suppression support in Hanksville from the area office located

Table 24: Present School Enrollment, Capacity, and Staffing Statistics
1982

District/School	Location	Distance from Proposed Federal Lease Unit (mi)	Enrollment	Present Capacity	Capacity (%)	Teachers	Student/ Teacher Ratio
Emery County			3,281	4,347	75.5	147	22:1
Castle Dale Elementary	Castle Dale	130	442	492	89.8	18	25:1
Emery County High School	Castle Dale	130	476	1,012	47.0	26	18:1
Cleveland Elementary	Cleveland	150	327	366	89.3	12	27:1
Ferron Elementary	Ferron	150	556	494	112.6	18	31:1
San Rafael Junior High	Ferron	150	350	403	86.8	16	22:1
Book Cliff Elementary	Green River	60	161	161	100.0	8	20:1
Green River High School	Green River	60	134	342	39.2	11	12:1
Huntington Elementary	Huntington	140	548	674	81.3	21	26:1
Canyon View Junior High	Huntington	140	287	403	71.2	17	17:1
Wayne County			555	592	93.8	32.5	17:1
Hanksville Elementary	Hanksville	70	52	82	63.4	3.5	15:1
Loa Elementary	Loa	120	239	239	100.0	12	20:1
Wayne Middle School*	Bicknell	110	119			7	21:1
Wayne High School	Bicknell	110	145	271	53.5	10	15:1

Source: Nellis, Lee, and John K. Nicholson, Utah State University Foundation, unpublished information (June 1983).
*Building has been condemned; nominal capacity is 271 but actual capacity is 0.

Table 25: Baseline Changes in Education Service Demands by County and Year

County/ Service Demand	Emery County					Wayne County				
	1985	1990	1995	2000	2005	1985	1990	1995	2000	2005
Students	816	1,416	1,716	1,516	1,516	48	98	158	198	238
Classrooms	33	57	69	61	61	2	4	7	8	10
Teachers	33	57	69	61	61	2	4	7	8	10

Source: Developed from guidelines prepared by the Department of the Community and Economic Development, State of Utah and the Utah State Planning Coordinators Office, UPED Model Output (June 1983).

Table 26: Baseline Projection of Additional Public Safety Requirements by County and Year

Service Demand	Emery County					Wayne County				
		1985	1990	1995	2000	2005	1985	1990	1995	2000	2005
Law Enforcement											
Police officers	6	7	8	7	7	1	1	2	2	3	
Patrol cars	6	7	8	7	7	1	1	2	2	3	
Jailspace (sq ft)	1,305	1,695	1,815	1,640	1,550	105	215	330	420	510	
Juvenile holding cells	1	1	1	1	1	1	1	1	1	1	
Fire Protection											
Fire flow (gpm)/ duration (hrs)	1,750/7	2,000/8	2,000/8	2,000/8	2,000/8	1,000/4	1,000/4	1,000/4	1,000/4	1,250/5	
Emergency Medical Service											
Ambulances	1	1	1	1	1	1	1	1	1	1	
Emergency medical technicians	7	7	7	7	7	7	7	7	7	7	

Source: Developed from guidelines prepared by the Department of Community and Economic Development, State of Utah and the Utah State Planning Coordinators Office, UPED Model Output (June 1983).

there (see table 26). Currently, there is no fire pumper at Hans Flat ranger station for structural protection. Wildland fires are suppressed with hand tools. An average of one wildland fire per year occurs in the Orange Cliffs area.

Health Care Services

Emery County does not have a hospital, and the closest facilities are the Castleview Hospital in Price (Carbon County) and the Allen Memorial Hospital in Moab (Grand County). There are three ambulances in Green River. Green River has a medical clinic staffed by a nurse practitioner, and a part-time dentist who visits the clinic once a week. Castle Dale has a clinic with two physicians, and there are two dentists in Castle Dale and one in Ferron. Mental health services are provided by the Utah Mental Health Services offices in Price and Castle Dale.

Wayne County residents generally use the Sevier Valley Hospital in Richfield. The Wayne County Clinic in Bicknell is staffed by a nurse practitioner and is visited by a doctor three days a week. There is a part-time dentist in Bicknell, and one mental health worker from the Utah District IV Mental Health Services is stationed there. Residents of Hanksville use clinic facilities in Green River or Bicknell; there is no clinic or other medical care facility available in Hanksville. There is one ambulance in Hanksville. The rangers stationed at Hans Flat have, at a minimum, received standard first-aid training.

For fire, emergency medical, and law enforcement incidents, there is a serious communications problem at the proposed federal lease unit. Hanksville currently has inadequate radio communication between field units and the sheriff's department at Loa, and there is no alarm or formal alert system for the fire department. The NPS uses a radio and radio-telephone communication system at Hans Flat, and the ranger at Hite is limited to radio communications only.

Public Utilities

At the present time, water and sewer services in the proposed unit are limited (well and septic system at the Hans Flat ranger station). The domestic water well at Hans Flat does not produce potable water, so water is currently trucked in at a cost of about $.05 per gallon. The septic system and leachfield can support a maximum of 15 people but only for short periods of time. Power is provided by a 20-kilowatt (kw) generator. The generator currently operates at or near capacity, with an annual fuel and maintenance cost of $12,500. No other developed potable water sources, sewage treatment and disposal facilities, or power sources are available near the lease unit. A private water company operates in the unincorporated community of Hanksville, about 50 miles west of the lease unit. Present and future capacity is not known. Hanksville has no central sewage collection or treatment facilities and does not have a formal solid waste collection and disposal system.

ATTITUDES AND LIFESTYLES

Outdoor employment and exploitation of natural resources from public lands are important economic aspects in Green River and Hanksville. Originally, these communities were established as Mormon farming settlements. Hanksville is one of the most isolated communities in Utah and retains its character as a farming settlement, but Green River has become increasingly dependent upon the tourist trade in the area and is a hub for several wilderness outfitters. Green River is also a major service town for traffic traveling I-70 across this portion of the state.

Historically, these communities have been culturally homogeneous and have valued their small-town way of life, community solidarity, and aesthetic and recreational opportunities as important lifestyle advantages. Both Hanksville and Green River have been minimally affected by energy-related growth and development. Residents of Green River generally agree that additional growth would be good and that the quality of the surrounding environment is fair to good (Southeastern Utah Association of Governments and Economic Development District 1980). Wayne County, including Hanksville, acknowledges potential conflicts between existing cultural values and population growth induced by energy development. However, the populace is generally supportive of tar sand development (Fawcett 1979).

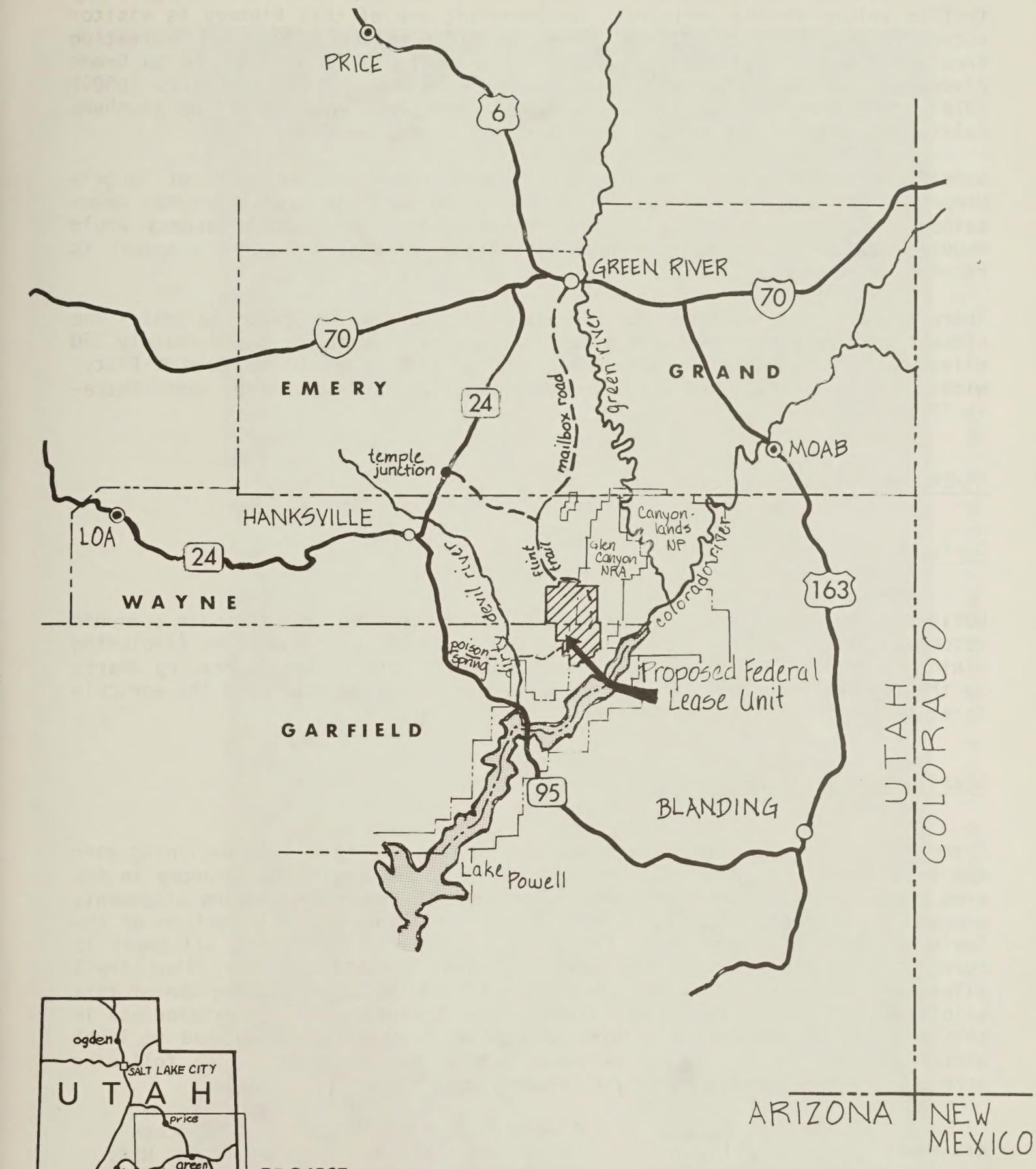
Conservation groups consider the area as having high national significance because of the outstanding scenic and recreational values and generally articulate strong preservationist attitudes (USDI, BLM 1981).

TRANSPORTATION AND ACCESS

Existing access routes into the lease unit include one potential main access route and one secondary route (see figure 39). The principal access would be via the Flint Trail from Temple Junction at UT 24 into the lease unit, or, alternatively, using a secondary road (unpaved) south from Green River to the Flint Trail and then into the northern portion of the unit. The second option would include using an unimproved road from UT 95 through Poison Spring Canyon, across the Dirty Devil River at a low water ford, and into the unit via Hatch Canyon and the South Fork of Happy Canyon.

The Flint Trail from Temple Junction to the NRA boundary is a class B bladed unpaved road maintained by the county. The Flint Trail within the recreation area is an unimproved dirt road. The Poison Spring Canyon route is not currently shown as a county road, and is not maintained (Main, pers. comm., NPS 1983).

Existing traffic volume on the Flint Trail is less than 10 vehicles per day (UDOT 1981). Traffic volume on the Poison Spring Canyon road is unknown, but likely is less than 10 vehicles per day. The primary users of these roads are visitors to the national recreation area, visitors to the public lands west of the proposed unit and associated parklands, and local livestock operators and ranchers.



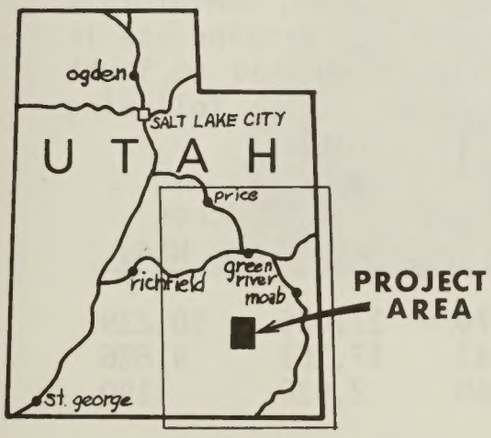


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Fig. 39 Access Routes

north

UT 24 between Hanksville and I-70 near Green River has an annual average daily traffic volume of 483 vehicles. An important use of this highway is visitor access to the Hite and Bullfrog marinas within Glen Canyon National Recreation Area and Capitol Reef National Park to the west. I-70 from UT 24 to Green River has an annual average daily traffic volume of 2,938 vehicles (USDOT 1978). I-70 is a major east-west route connecting Denver with the southern California metropolitan areas.

Subsidiary access within the proposed federal lease unit consists of largely unmarked four-wheel-drive trails (see figure 40). These trails are not maintained on a regular basis, and their suitability for vehicle access would require analysis on a case-by-case basis once a specific access proposal is received from the applicants.

There are currently no petroleum product pipelines near the proposed unit. The closest regularly scheduled air service is at Grand Junction, approximately 250 miles away. There is an unimproved public dirt airstrip at Gordon Flats, within the lease unit, and the nearest railhead is at Green River, approximately 70 miles away.

OTHER SECTORS

Agriculture

Until the early 1970s, agriculture (farming and ranching) was the main economic resource of the region. Since then nonagricultural industries (including mining, petroleum exploration, and tourism) have contributed increasing shares to the regional economy. This trend is expected to continue, and the agricultural sector is expected to decline proportionally.

Grazing and Livestock Production

Although grazing and livestock production in the area have been declining over the past few years, they still remain important factors of the economy in the area surrounding the proposed unit. Portions of three BLM grazing allotments are within the unit--Robbers' Roost, Flint Trail, and a small portion of the Sewing Machine allotment (see figure 41). The Robbers' Roost allotment is currently allotted, as is the Sewing Machine allotment. The Flint Trail allotment is currently in unallocated status, and the light grazing use of this allotment is by wildlife (mainly deer) and by trespass cattle. Grazing use in this portion of the Sewing Machine allotment is essentially limited to light winter use due to a lack of permanent stock water sources. The following acreages are for the BLM grazing allotments within the lease unit:

Allotment	Allotment	Area Within Lease Unit	NPS Acres NRA	BLM Acres Total	BLM Acres WSAs
Robbers' Roost	205,929	16,296	5,270	11,026	10,239
Flint Trail	115,389	37,694	20,543	17,151	9,686
Sewing Machine	129,316	11,190	8,560	2,630	190

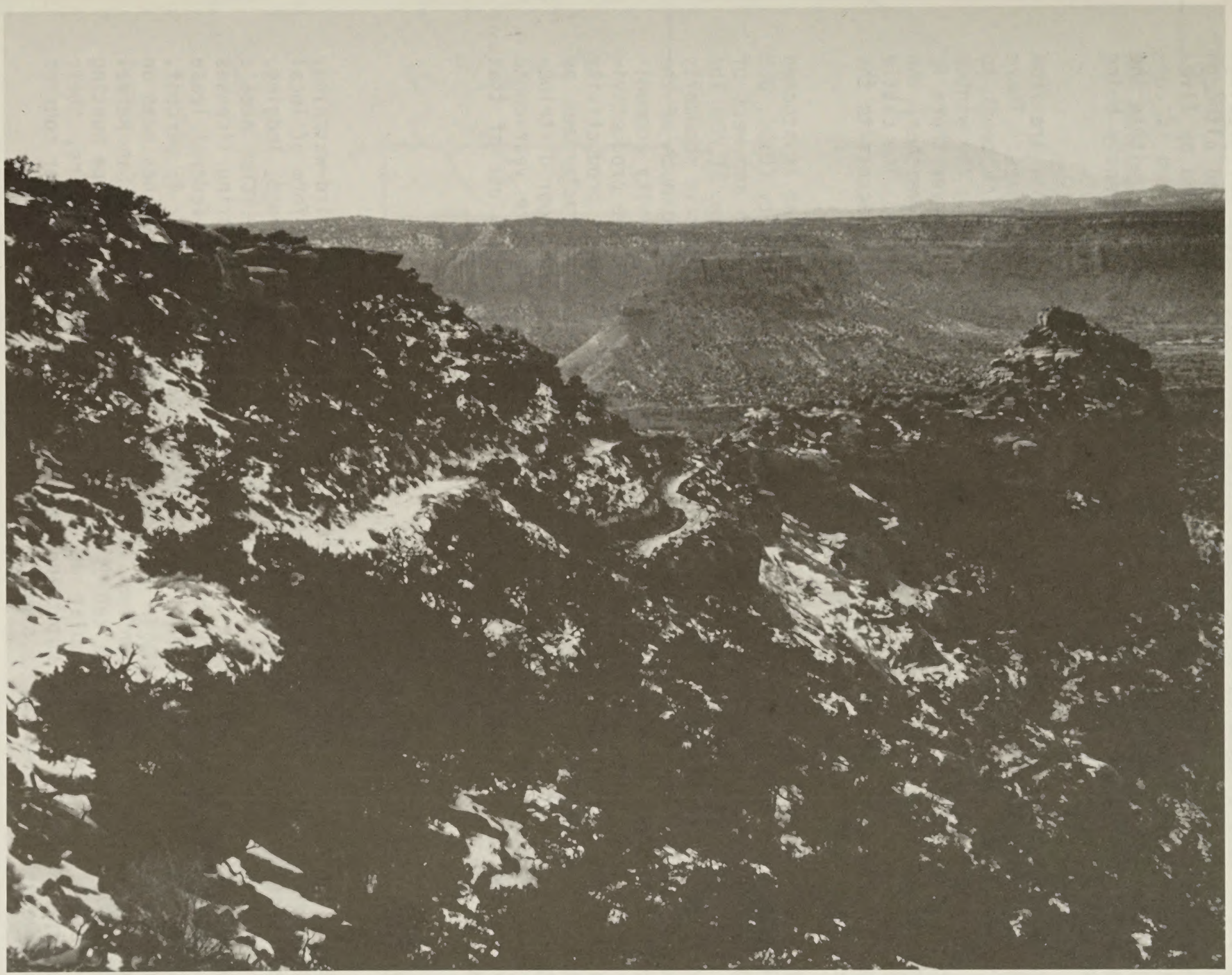

Fig. 40. Typical Road from Mesa Top into Canyons

Three state land allotments within the proposed unit are leased for grazing. Two are within the otherwise unallotted Flint Trail allotment, and although these sections are under lease, they currently are not being grazed by livestock. The third section is within the Robbers' Roost allotment and is currently being grazed by livestock (see figure 41). The two sections within the lease unit that are within the Sewing Machine allotment are currently being grazed.

The only stock water available on the allotments lying within the unit are from small springs and dirt stock tanks generally located along ridge tops. There is limited forage available near each of these water sources, which tends to keep the number of livestock using each water source small. During the winter months, cattle scatter across the Orange Cliffs and Big Ridge wherever there is forage because snow provides a ready source of water. In warm weather, the cattle are restricted to forage areas near permanent water sources. The cattle are also largely restricted year-round to the mesa tops, because access to the lower canyon bottoms is limited near permanent water sources.

Grazing data for the Robbers' Roost allotment indicate the allotment is stocked at slightly less than half of its total estimated carrying capacity (USDI, BLM 1982b). The desert grassland vegetative community located north and west of the lease unit has the highest potential herbaceous productivity (1,200 lb/acre/yr) of any found within the area, but little of this vegetative community is found within the unit. The pinyon-juniper community covering much of the lease unit is among the lowest (at 50 or less lb/acre/yr) productivity communities in the area. Data are insufficient to quantify the vegetative productivity within the unit itself, but given the prevalence of lower productivity vegetative communities, annual forage production could be characterized as being at the low end of the productivity range for the region. Poor distribution of livestock due to rough terrain and the lack of adequate year-round water sources also places practical restrictions on the grazing use of that portion of the allotments that lies within the proposed lease unit.

Hunting and Fishing

Hunting, fishing, and nonconsumptive uses of wildlife resources (bird-watching, wildlife photography) bring in income to the local economy in the form of local expenditures by outsiders visiting the national recreation area (food, lodging, gas, sporting goods). Hunting is an allowable use of the recreation area's resources and is regulated by the state of Utah. In 1982, 117 hunting licenses were issued for deer herd no. 29 in the vicinity of the proposed federal lease unit, and the hunting success rate (bucks only) was approximately 45 percent. Antelope hunting in the vicinity of the proposed federal lease unit has been on the decline in recent years, and no licenses were issued for the San Rafael herd in 1979-82 (UDWR 1983; see tables 15 and 16 for deer and antelope hunting information). Fishing is popular on the Green and Colorado rivers, their tributaries, and Lake Powell, but there are no permanent ponds or water courses within the unit large enough to support game fish.

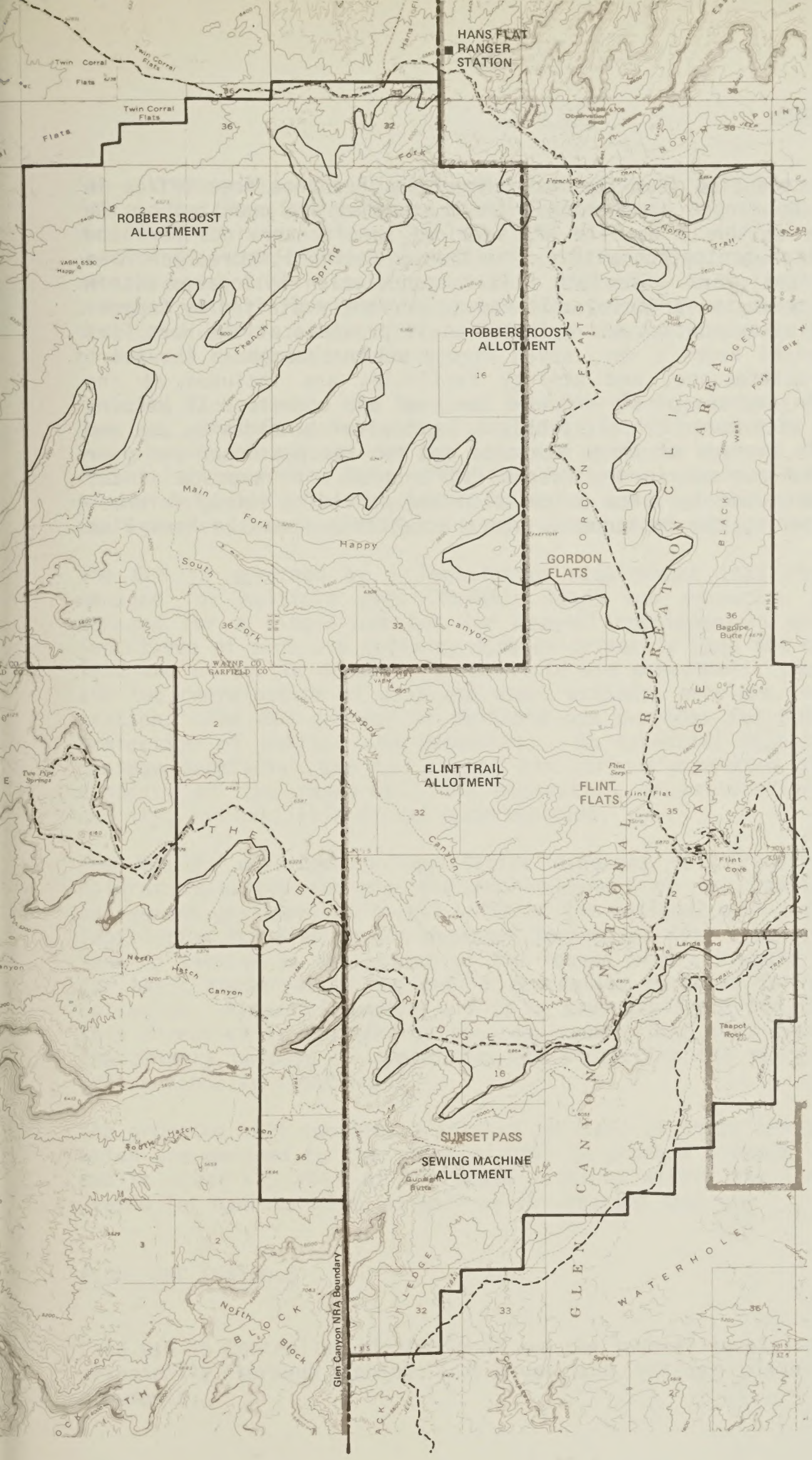

Fig. 41. Grazing Allotments

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BLM and NPS Operations

BLM operations are conducted from the Henry Mountains Resource Area Office in Hanksville, Utah. No ranger or permanent field stations are operated by the BLM in the vicinity of the unit. The NPS provides special services for land management and visitor protection within Glen Canyon National Recreation Area and Canyonlands National Park. The Hans Flat ranger station is located within Glen Canyon just outside the proposed unit and is currently staffed by Canyonlands personnel. Visitor contact and orientation is provided at the Hans Flat entrance station, eight hours a day, seven days a week, throughout the year. Employee housing, maintenance, and utility facilities are included at the contact station. An average of 60 workdays per year are committed to helping visitors and others with motor vehicle problems (mechanical breakdowns, gas and water problems). An average of three searches and two rescues occur per year for lost and injured persons in the Orange Cliffs area. An average of 215 workdays per year are used for area orientation and providing safety information to persons entering the backcountry areas accessible from the Hans Flat area.

LAND USE

The eastern portions of the proposed federal lease unit are administered by the NPS as the Glen Canyon National Recreation Area, and the western portions are public lands administered by the BLM. There are five state land section inholdings within the national recreation area and seven within BLM-administered lands (see figure 42). There are no private lands within the proposed unit. Tar sand resources accessible from state sections could be developed under standard state oil and gas leases issued by the Utah Department of Natural Resources and Energy.

Existing land uses in the Tar Sand Triangle geographic area include recreation, hunting, wildlife habitat, mineral activities, and livestock grazing. Land use and planning for lands in and near the proposed federal lease unit are the responsibility of the BLM and the NPS; both are agencies of the U.S. Department of the Interior. The management mandates and controlling legislation for the two agencies, however, differ in several major respects.

The BLM is governed by a legislative requirement that the public lands be managed for multiple uses (FLPMA); lands and resources generally are not managed for a single use but for several complementary uses. The relative importance of each use activity depends primarily upon the capabilities of the land and on public demand. In multiple use management, the interrelationship and the coordination of uses and users presents problems in resource administration. The BLM concept of multiple use provides for both the use and the protection of public land resources. An essential objective is to promote maximum beneficial use for all of the various resources consistent with the capacity of the resources, the protection or restoration of environmental quality, and available fiscal opportunities.

The NPS is governed by legislative mandates that require conservation of natural resources for the use and enjoyment of the public, and this basic management goal applies to all units of the national park system. The enabling legislation for Glen Canyon National Recreation Area also provides for mineral leasing insofar as extraction of the leased minerals would be compatible with the basic conservation and public recreation purposes for which the unit was set aside. Mineral resources are to be made available for consumptive use, but this directive is tempered by the requirement that such uses be subordinate to the primary purpose of preserving and protecting the resources that make the unit nationally significant.

The proposed unit contains scattered sections of state lands (school section), which are managed by the state of Utah to produce revenues for the support of public schools. Most of the state sections within the lease unit have been leased for hydrocarbons, as well as for grazing use.

PLANS AND CONTROLS

Land use is controlled at the local and the federal levels in the project area, principally through zoning ordinances and various planning and management documents.

Local

Wayne and Garfield counties recognize the value of the region's spectacular scenery and outstanding natural landmarks in planning land use. Wayne County administers its land use planning from the Final Report, Wayne Country Master Planning Project (Call Engineering, Inc. 1976). Garfield County administers its land use from the Garfield County, Utah, Master Plan for Development (University of Utah, Bureau of Community Development 1979). The multiple use of federal lands, particularly as a mechanism to encourage economic growth, is also emphasized.

State

The State Land Board manages state section inholdings within Glen Canyon National Recreation Area and within lands administered by the BLM. The state grants grazing and mineral leases on these state school sections and administers these sections without formal land use plans.

Federal

Federal lands within and adjacent to the lease unit are managed by two separate agencies within the Department of the Interior, as previously stated. Each agency has separate and distinctively different management responsibilities.

The BLM manages their lands under guidelines contained in the Multiple Use Management Decisions, Henry Mountains Planning Area (USDI, BLM 1982c), which designates the public lands within the proposed federal lease unit as acceptable for leasing if sensitive resources can be adequately protected by protective restrictions. BLM lands within the lease unit are currently designated as category 1 (lease with standard restrictions).

Managing NPS lands within the lease unit is guided by the enabling legislation for Glen Canyon National Recreation Area. The General Management Plan for Glen Canyon (USDI, NPS 1979) classifies the lands within the lease unit that lie within NRA boundaries into either a recreation and resource utilization (RRU) or natural management zone. The Minerals Management Plan (USDI, NPS 1980) further delineates allowable uses of these two zones regarding mineral disposition and development. The RRU zone allows for maintaining natural processes for both mineral extraction and livestock grazing to the extent that these activities do not unduly impair natural processes. The granting of new mineral leases in an RRU management zone is subject to a finding of no significant adverse effects on the conservation and management of natural processes and on administration of NRA including such activities as recreation. The natural management zone is closed to mineral disposition and development, subject to valid existing rights, and existing leases lying with the natural zone are not eligible for conversion to combined hydrocarbon leases. The Natural Resource Management Plan (USDI, NPS 1983) identifies the need for comprehensive impact analysis and mitigative requirements for resource use and objectives within the national recreation area.

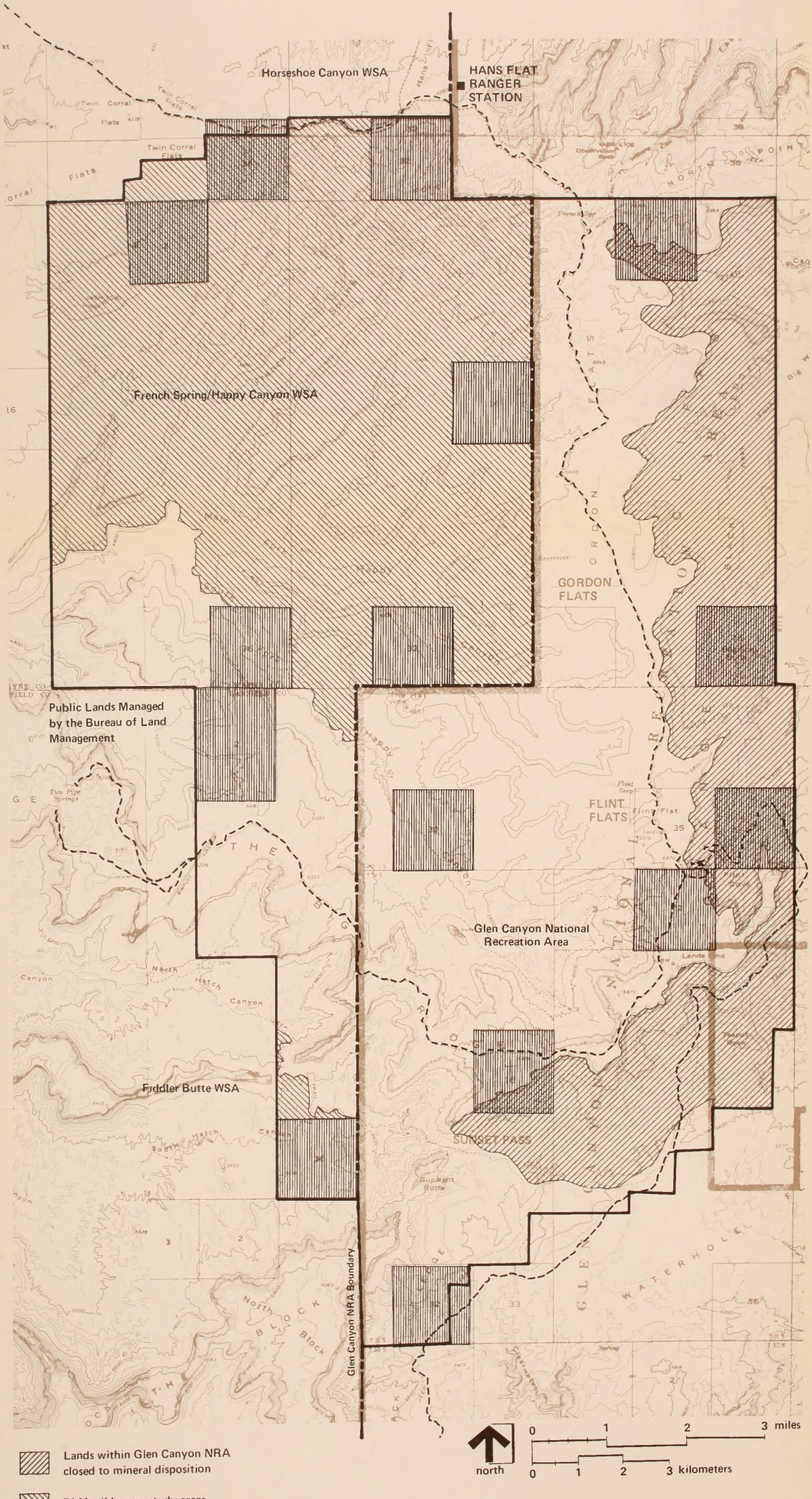
Horseshoe Canyon WSA
HANS FLAT RANGER STATION
French Spring/Happy Canyon WSA
GORDON FLATS
Public Lands Managed by the Bureau of Land Management
FLINT FLATS
Glen Canyon National Recreation Area
Fiddler Butte WSA
SUNSET PASS
Glen Canyon NRA Boundary
north
0 1 2 3 miles
0 1 2 3 kilometers
Lands within Glen Canyon NRA closed to mineral disposition
BLM wilderness study areas
State land sections

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Fig. 42. Land Status

The General Management Plan for Canyonlands National Park (USDI, NPS 1978) and the Assessment of Alternatives for the Plan (USDI, NPS 1977) identifies the present management objective for contiguous areas of Canyonlands as: "to manage the Maze District as a rugged, wild area with remoteness and self-reliance as the principal elements of visitor experience. Facilities and programs will be kept to a minimum with their primary purpose being information, orientation and safety. Personal interpretive contacts will be kept informal."

REGIONAL RECREATION VALUES

Within a 50-mile radius of the lease unit there is a unique concentration of scenic attractions, including four state parks (administered by the state of Utah); three national parks, one national monument, and one national recreation area (administered by the NPS); two national forests (administered by the U.S. Forest Service); and extensive public lands (administered by the BLM). The varied landscapes that form a major attraction to visitors to the region include deserts, the extensive canyonlands related to the Colorado River system, Lake Powell, and forested mountains. Approximately 97 percent of the visitors to this area originate from outside the region.

LOCAL RECREATION PATTERNS

The high quality recreational and scenic resources within and around the proposed unit are of national significance (P.L. 92-593; Findley 1971). Two-wheel-drive dirt access roads from I-70 to the north and UT 24 from the west lead to the Hans Flat ranger station, the initial contact point for visitors to the Maze district and the Horseshoe Canyon detached unit of Canyonlands National Park; the Orange Cliffs area of Glen Canyon National Recreation Area; and adjacent BLM-administered lands.

The management objectives of the Maze district and the Horseshoe Canyon detached unit of Canyonlands and the Orange Cliffs area of Glen Canyon are to maintain these areas in a primitive undeveloped condition, with remoteness and self-reliance the principal elements of the visitor experience (see table 27 for a summary of visitor use at Hans Flat ranger station from 1978 to 1982).

Table 27: Visits Recorded at Hans Flat Ranger Station

Month	1978	1979	1980	1981	1982
January	46	4	2	153	49
February	27	4	6	38	55
March	449	262	147	232	279
April	385	519	558	575	634
May	777	545	685	724	572
June	677	218	218	104	611
July	289	87	105	90	115
August	204	67	128	117	185
September	311	339	205	185	251
October	244	231	297	186	245
November	120	30	70	128	107
December	3	24	119	68	29
Total	3,532	2,320	2,540	2,600	3,132
Change		-34%	+9%	+2%	+20%

Source: Monthly Public Use Reports, Canyonlands National Park.

Hunting is allowed on NRA lands and BLM lands but not within Canyonlands National Park. Hunting, particularly larger game species such as deer and antelope, is an important recreational use of lands within the proposed federal lease unit (see tables 15 and 16). The issuance of hunting licenses and the regulation of hunting on federal lands is the responsibility of the state of Utah. Antelope hunting has been on the decline in recent years, and no licenses were issued for the San Rafael herd in 1979-82 (UDWR 1983). In 1982, 45 percent of the deer hunters were from Carbon and Emery counties, and 97 percent were Utah residents, according to UDWR records for deer herd no. 29. Opportunities for hunting desert bighorn sheep in the area are being developed through a UDWR reintroduction program (see table 28 for a summary of existing recreation activities in the immediate vicinity of the proposed federal lease unit).

Although recreation potential for the area is considered outstanding, the isolation from major population centers, the lack of recreation development, and the lack of publicity have resulted in only moderate visitor use. Private outfitters sporadically provide wilderness experiences in the Maze district and in the Horseshoe Canyon detached unit of Canyonlands National Park and within the surrounding BLM-administered WSAs.

Table 28: Recreational Activities

Administrative Unit	Recreation Resources	Visitor Activities
Glen Canyon National Recreational Area (Orange Cliffs area)	A remote peninsula that serves as a major vantage point for spectacular vistas into the Dirty Devil drainage, Elaterite Basin and Canyonlands; also serves as a backdrop for scenic views from Canyonlands	Two- and four-wheel-drive motor touring, dispersed camping, backpacking, photography, horse use, picnicking, cross-country hiking, aircraft and wildlife sightseeing
Canyonlands National Park	A labyrinth of remote canyons, weathered rock spires and buttes containing important archeological and geologic resources, particularly pictograph sites	Interpretation, four-wheel-drive motor touring, primitive camping, backpacking, wilderness experience, photography, horse use, archeological, aircraft and wildlife sightseeing, scientific study
Canyonlands National Park (Horseshoe Canyon detached unit)	A remote, steep-walled canyon containing important archeological resources, particularly pictograph sites	Interpretation, dispersed camping, backpacking, photography, horse use, archeological and aircraft sightseeing
Public lands administered by BLM, including WSAs	Desert landscapes with canyon complexes, weathered rock spires and buttes containing a variety of prehistoric and historic cultural resource sites	Two- and four-wheel-drive motor touring, primitive camping, backpacking, fishing, hunting, photography, horse use, cross-country hiking, archeological and wildlife sightseeing, occasional float boating on Dirty Devil River, aircraft sightseeing

WILDERNESS RESOURCES

Nine potential wilderness areas are located near the proposed federal lease unit. These areas are listed in table 29, and those nearest the lease unit are shown on figure 43. About 19,910 acres of the BLM French Spring/Happy Canyon WSA lies within the unit, as do portions of the BLM Horseshoe Canyon WSA (58 acres) and Fiddler Butte WSA (106 acres). Intensive inventories have determined that these WSAs meet the wilderness criteria established in section 2(c) of the Wilderness Act of 1964, which states the following:

> A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

Under the BLM interim management criteria, the WSAs near the proposed federal lease unit must be managed to preserve wilderness values until such areas are dropped from consideration as wilderness by Congress (USDI, BLM 1979). This nonimpairment standard allows the issuance of mineral leases but prevents any activity on those leases that would impair wilderness values.

In addition to BLM wilderness study areas under the authority of the Federal Land Policy and Management Act, the NPS has recommended wilderness designation for several NPS areas near the proposed unit to the Department of the Interior, including the Maze and Horseshoe Canyon districts within Canyonlands National Park (USDI, NPS 1974). To date, no Congressional action has been taken on these recommendations. NPS Management Policies (1976) state that wilderness areas should be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, including outstanding opportunities for solitude or a primitive and unconfined type of recreation. These objectives apply to areas studied and recommended for wilderness designation, as well as to those areas that have been formally designated as wilderness. About 11,494 acres of the recommended Orange Cliffs wilderness area within Glen Canyon National Recreation Area are within the federal lease unit as originally proposed by the applicants but coincides with areas that are closed to mineral disposition by the approved Minerals Management Plan for Glen Canyon National Recreation Area (USDI, NPS 1979). In addition, the recommended Dirty Devil wilderness area within Glen Canyon lies about 9 miles to the west of the proposed federal lease unit (see figure 43).

Table 29: Potential Wilderness Areas

Proposed Area	Acres	Acres in Lease Unit	Status
Glen Canyon National Recreation Area			
Dirty Devil	21,625	0	recommended (1979)
Orange Cliffs	53,905	*11,494	recommended (1979)
Canyonlands National Park			
Maze district	102,200	0	recommended (1974)
Horseshoe Canyon detached unit	2,500	0	recommended (1974)
BLM-administered Lands			
UT-060-045 (Horseshoe Canyon North)	20,550	0	WSA
UT-050-237 (Horseshoe Canyon South)	40,840	58	WSA
UT-050-236A Dirty Devil	61,000	0	WSA
UT-050-236B French Spring/ Happy Canyon	25,000	19,910	WSA
UT-050-241 Fiddler Butte	62,200	106	WSA
Total Acres	389,820	20,074	

*Coincides with portions of Glen Canyon National Recreation Area closed to leasing by the approved Minerals Management Plan; these areas are not eligible for lease conversion and are not included in the total.

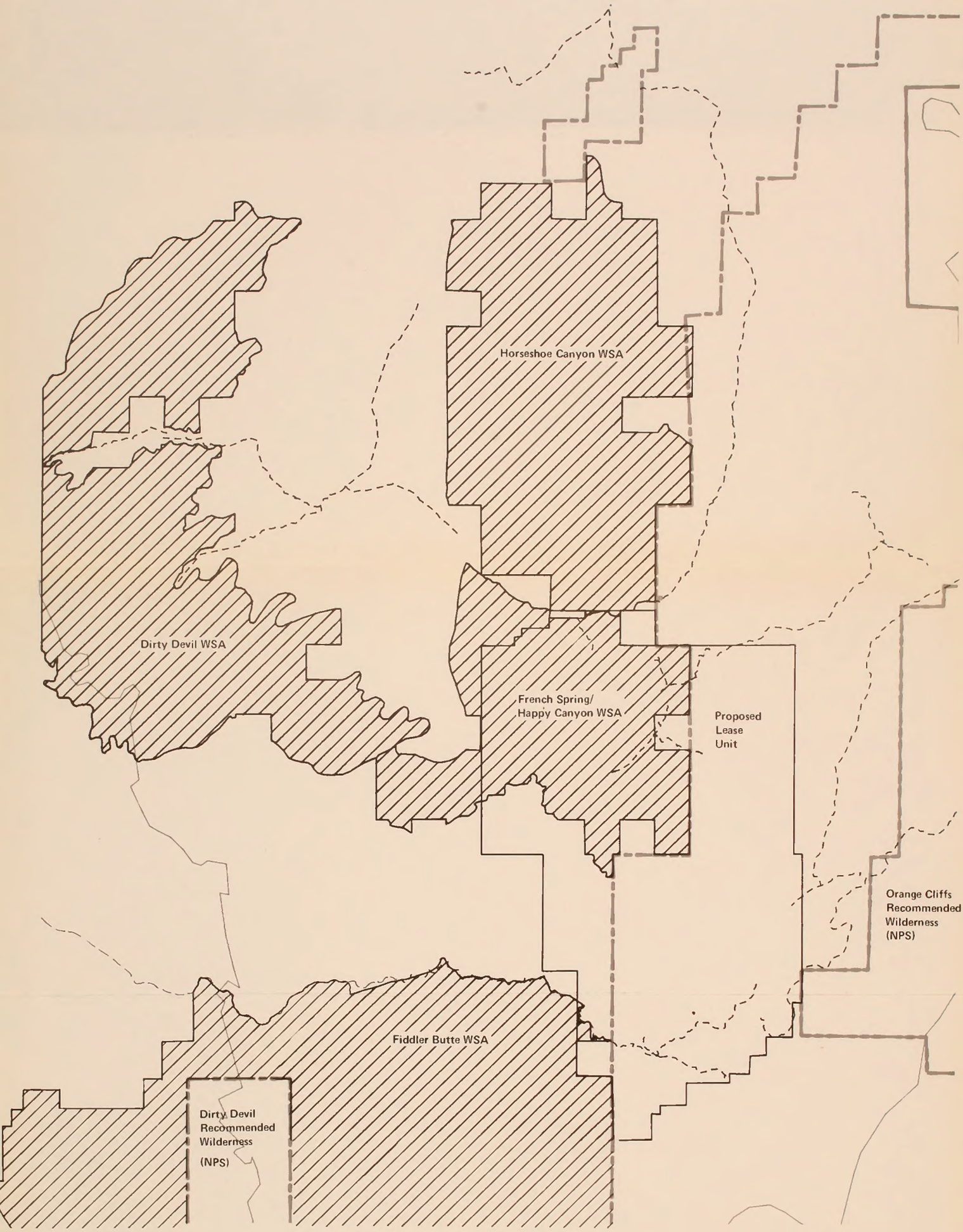

Fig. 43. BLM Wilderness Study Areas

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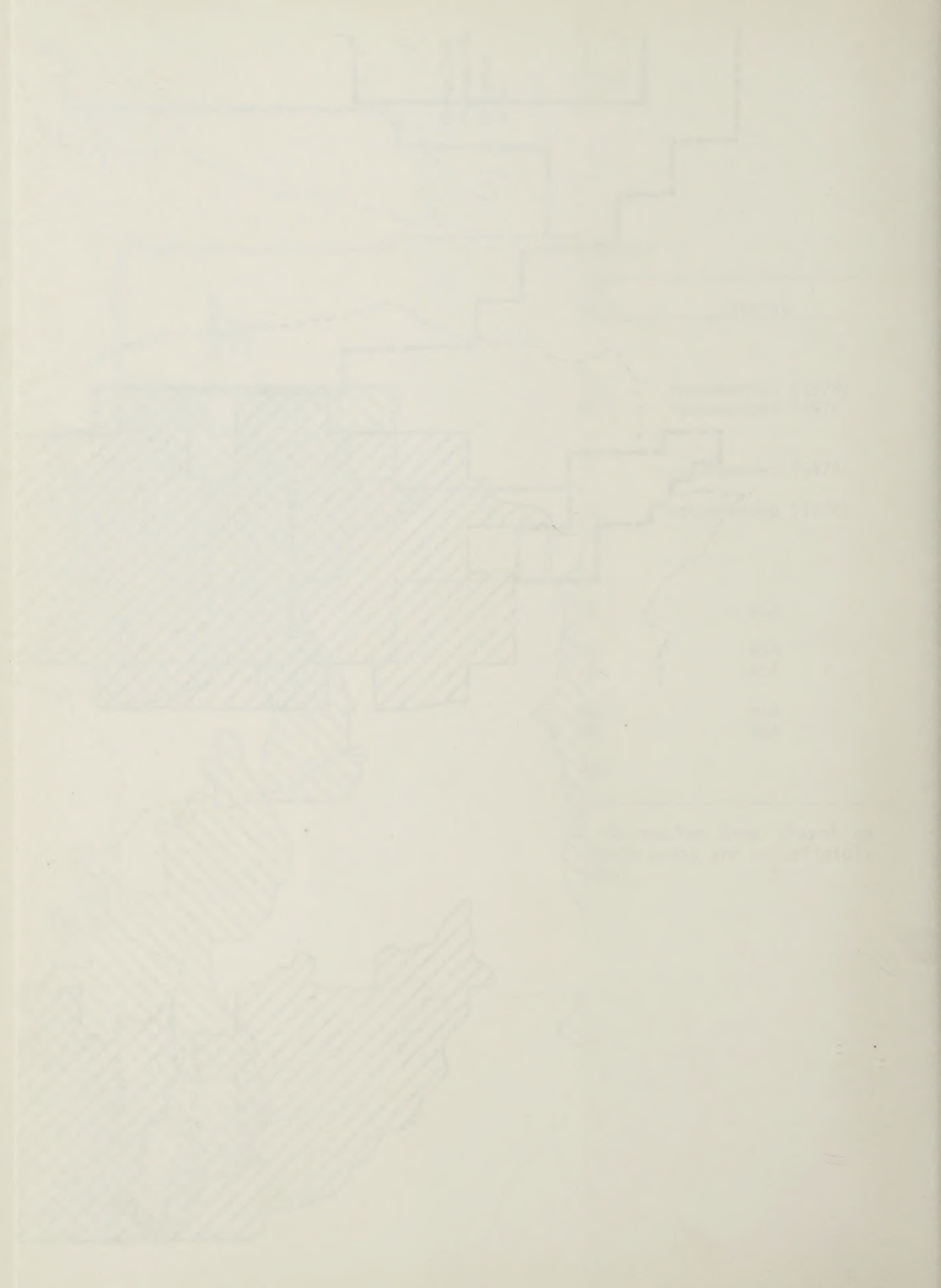
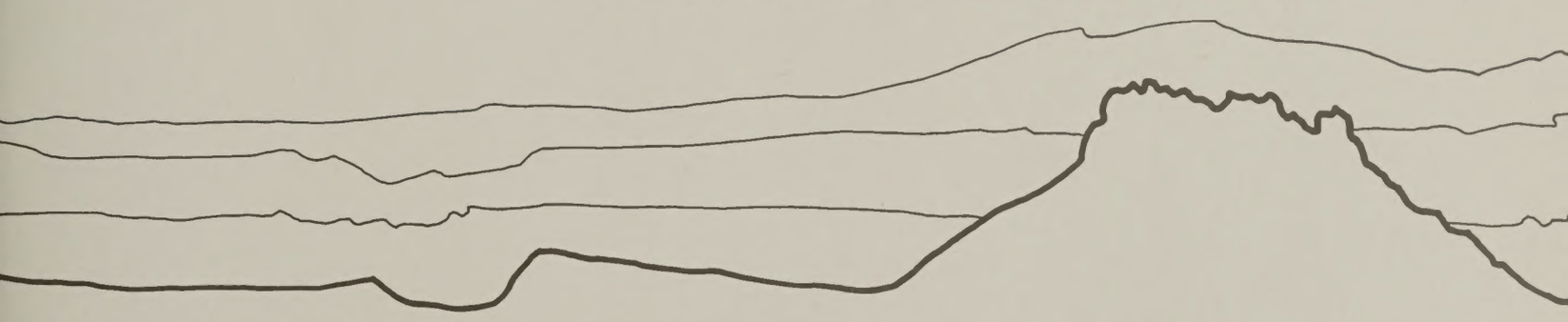


ENVIRONMENTAL CONSEQUENCES



ALTERNATIVE 1: CONVERT ALL LEASES (PROPOSED ACTION)

The following section outlines the impacts expected if the applicants' proposal was initiated through lease conversion. The "Alternatives Including the Proposed Action" section describes the four-phase development (phase IV) proposed by the applicants. The full-scale commercial development assumes a 30,000-bpd production level. The general restrictions contained in appendix C would be applied. Eligible federal leases (totaling 38,453 acres) within the proposed 66,040-acre lease unit would be converted based on the applicants' plan of operations; 15 federal leases or portions of the leases (totaling 6,884 acres) are located within the area closed to mineral disposition on NRA lands and are not included in this analysis (see figure 4).

IMPACTS ON NATURAL ENVIRONMENT

Geologic Resources

Activities during phases I and II would not noticeably affect the geologic resources within the proposed federal lease unit. Impacts from drilling 2 phase I coreholes and 15 phase II coreholes to the base of the White Rim sandstone would be small and transitory.

However, phase III and IV activities would directly affect the geologic resources. The White Rim sandstone, and possibly the overlying Moenkopi formation, would be extensively fractured to increase the permeability of the tar-saturated sandstone. High-pressure steam would be injected into the tar sand reservoir. The steam, condensed water, and any added solvents, such as those used in traditional enhanced recovery operations, could chemically react with the hydrocarbons and the minerals (silicates, carbonates, clays, sulfides, and other constituents) of the reservoir rock; this could result in a change in the chemical composition and physical characteristics (such as permeability and porosity) of the rock. Because little is known about subsurface changes that may occur during tar sand extraction, the extent of such changes cannot be accurately estimated at this time. If the steam-drive process can be adequately controlled, changes within the subsurface geologic formations could be limited to a 200-foot radius around each injection well in the horizontal plane, and to the thickness of the White Rim sandstone (with possible incursions into the overlying Moenkopi) in the vertical plane. If the process cannot be adequately contained within the White Rim tar sand layer, fracturing of layers above and below the sandstone could occur and may extend over a much larger area than indicated by the surface extent of the extraction zone.

For phase III, these effects would be restricted to the immediate vicinity of the pilot operations at Gordon Flats; for phase IV, up to 18 prospective areas (extraction zones) would be affected throughout the federal lease unit (see figure 2).

The structural qualities of the rock could be especially affected during phase IV. Steam alteration of some of the minerals in the White Rim sandstone (and perhaps in other formations, if uncontrolled steam excursions occur), such as

removing the soluble sodium, potassium, and silica compounds and alteration of the matrix rock to clays and perhaps zeolites, could weaken the sandstone in the vicinity of each injection well during phase IV. If such weakening is pervasive, subsidence could eventually occur; the exact amount cannot be predicted at this time. The percentage of feldspar and other steam-alterable minerals present, the well spacing, the length of time the steam is applied, and the temperature of the steam are all factors. Subsidence would not be noticeable on the surface unless rock stresses affect existing fractures at the surface or near cliff faces where rockfalls could result.

Topographic Resources

The topography would be slightly altered during phases I and II due to pad and access construction and during phase III operations due to road upgrading, wellfield preparation, and pilot plant construction. Phases I and III alterations would be limited in extent and duration and would not involve large-scale disturbances because of the relatively flat terrain in Gordon Flats. Although phase II disturbances would be scattered throughout the proposed unit, major effects on the topography are not expected.

Constructing wellfields and upgrading facilities and associated activities during phase IV, such as road building, would alter the topographic features. However, because the proposed in-situ extraction process does not require the use of mining methods, the large-scale topographic disturbances associated with mining (particularly surface mining) would not occur.

Small quarrying operations for gravel and other construction, road, and pad maintenance materials could be necessary in the vicinity of the proposed lease unit. The size and location of such operations is not known, but quarrying efforts would substantially alter the topographic aspect of the quarry area.

The cumulative changes in topography over the life of the four-phase development would result in a change from a landscape where human alteration is inconspicuous to one that is noticeably manipulated by human activity. These changes would include mounded roadfills, ditches, stockpile and material mounds, solid waste disposal sites, and filled and leveled areas for the construction of ancillary facilities. Although the applicants would be required to reclaim these areas, the original topographic features would not be restored.

Paleontological Resources

Direct effects such as loss of paleontological resources would be unlikely during phases I, II, and III. Fossil resources not previously known could be discovered during drilling operations. Indirect effects such as unauthorized collection and vandalism could increase during these three phases but are not expected to have a major impact on the area's paleontological resources.

Over time, the phase IV extraction zones could extend into areas where there are known paleontological resources, particularly petrified wood. Some

paleontological resources could be damaged or destroyed by onsite activities. Secondary effects, such as increased collection and vandalism, and particularly collection of petrified wood, would probably occur due to the increased numbers of people who would enter the area. These impacts could be minimized by the applicants managing the employees and by increased educational and resource protection efforts by the BLM and the NPS. Although impacts to paleontological resources would still occur, these are not a major resource aspect of the proposed unit.

Energy and Minerals

Direct effects on energy and mineral resources are not anticipated under phases I and II, because no resource extraction or large-scale subsurface disturbances are planned. New information about the quality and quantity of the tar sand resource would be acquired during these two phases.

During phase III, some bitumen would be extracted for experimental purposes, but since no major commercial extraction on a continuing basis is not contemplated, no major effects on the amount, nature, or quality of available tar sand are expected. Any such effects would be confined to the immediate vicinity of the phase III operations.

However, major tar sand bitumen extraction is proposed during phase IV operations, and the amount, nature, and quality of the tar sand available for future extraction within the proposed federal lease unit would be affected. The efficiency of the proposed extraction method is not known; therefore, it is not possible to predict the quality and total amount (in barrels) of oil that would be produced. Production is projected for 30,000 bpd at full operational level, for a period of up to 160 years. The extent and amount of tar sand resource present within the proposed unit has not been adequately defined, so the diminution of the amount of reserves due to this operation cannot be accurately estimated at this time. The extracted resource could become a marketable petroleum fuel and contribute to overall petroleum products available in the U.S. if present economic conditions improve.

Overall energy efficiency of mineral extraction is the net energy output, divided by the net energy input, times 100. Energy output is energy contained in the product. Energy input is the fuel consumed in producing the final product, including the fuel value from the material being converted (tar sand resource) and from other sources. Transportation of raw materials to a plant and transportation of products and waste materials from a plant are also direct energy inputs. Indirect energy inputs include energy required to produce materials and fuels used by a plant. Each material and fuel has an energy requirement for its production and development. Infrastructure energy includes energy used by employees, their families, and secondary industries (including social services) supported by the employees and their families. Table 30 compares energy production from tar sand and other energy extraction processes.

Table 30: Comparative Energy Efficiency

Type of Energy Extraction	Efficiency (%)
Oil from tar sand in-situ	20 to 30
Shale oil from an underground mine	30 to 40
Crude oil to petroleum products	30 to 40
Electrical power from coal	
Strip mines	33 to 43
Underground mines	31 to 41
Uranium to electricity	17 to 27
Electrical power from natural gas	35 to 45
Oil from tar sand strip mine	45 to 55

Source: "Energy Analysis Handbook for Preparation of Oil Shale Development Environmental Impact Statements." Prepared by BLM, Colorado State Office 1982.

The energy analysis is based on the following information supplied by the applicants:

The commercial (phase IV) plant would produce 30,000 bpd of bitumen.
Bitumen recovery would be 80 percent of the in-place resource.
Average operational employment would be a maximum of 400 workers.
Upgraded syncrude would total 20,700 bpd.

Based on the applicant's information, the energy efficiency calculated for the steam drive process would be as follows:

Inputs (Btu/day)

fuel used	0.1×10^{10}
indirect energy	0.4×10^{10}
infrastructure energy	0.5×10^{10}
Total	1.0×10^{10}

Resource (bpd)

in-place bitumen	37,500
recovered bitumen	30,000
upgraded syncrude	20,700

Outputs (Btu/day)

upgraded syncrude	11.3×10^{10}

This indicates an energy return of about 11 to 1 (energy recovered compared to energy expended) and a projected recovery of 80 percent. Another way

to view the energy output is to include the tar sand bitumen used as a fuel input in extraction and processing. In that case, each 1 Btu invested would yield 1.85 Btu of "new" energy, resulting in a net gain of 0.85 Btu. An extraction efficiency of 80 percent of the in-place resource is, however, much higher than comparative energy efficiencies typical of other types of conventional and synfuels energy processes (see table 30).

The above energy analysis, is, of necessity, highly speculative. Some of the more critical uncertainties are the resource recovery ratio, the steam to oil ratio, the character of the upgraded syncrude and feasibility of the proposed process in this geologic environment.

The availability of uranium reserves within the lease unit could be reduced by phase IV activities. If uranium ores are present in the Chinle formation, wells drilled through uranium ores would preclude recovery of uranium during tar sand operations and reduce future recovery. Because the exact location and nature of potential uranium resources in the vicinity of the phase IV operations are not known, the loss of these resources cannot be accurately quantified at this time.

Water Resources

Surface disturbances associated with phase I and II activities would result in minimal increased runoff and erosion, but these effects are expected to be localized and short lived. Increased runoff and erosion at the phase III operation site is not expected to be major. Phase IV activities could not only result in increased runoff and erosion but affect the recharge areas for springs and seeps in and near the proposed unit. Produced hydrocarbons and process fluids and liquid wastes could enter local drainages due to spills. Careful management would minimize the amount of materials entering the drainages.

Phase IV operations would require settling and surge/storage ponds, which are subject to spills, overflows, and leaks. Local degradation of perched groundwater on or near the mesa top in the Navajo and Kayenta formations by effects on the surface recharge areas could occur. An abrupt pond failure resulting in a rapid spill on a mesa top would cause locally severe erosion and a noticeable discoloration on the cliff faces and underlying slopes. The southeastern portion of the lease unit is particularly likely to be affected by any leaks or spills, since this area drains directly via steep drainages to the Colorado River (see figure 26). Any loss of available water in this water-poor area, whether through diminishing flows or by effects on quality, is considered serious.

Constructing a water supply pipeline in Happy Canyon would contribute to sediment load to and within the Dirty Devil River during and for sometime after construction, as would any breaks during the operational life of the pipeline. Raw water pumped from the Dirty Devil River to the commercial-scale operation site at Gordon Flats would be desilted at the plant site, probably in settling ponds. Total raw water demand over the life of the project is estimated to be up to 268,640 acre-feet. The exact quantity of suspended solids, mostly fine particles of clay and silt, varies seasonally in the Dirty Devil River, but the

pumped water could average as much as 1,000 milligrams per liter (mg/l). Over the 160-year projected life of the project, a total of approximately 10 million cubic yards (or about 170 cubic yards per day) of such material could be deposited in desilting ponds. These materials if disposed of at or near the plant site on the mesa top would be more subject to erosion and contain more soluble salts than the native sandy soils and could cause local degradation of surface water runoff. Revegetation to prevent erosion could be difficult to achieve. The effects of increased erosion would be most noticeable near disturbed areas and disposal sites, and where ephemeral, intense runoff cascades over benches and cliffs, leaving a deposit of light-colored, less weathered sediment at the base of cliffs and in stream channels.

During phases I, II, and III, drilling could produce a small amount of water from each of several formations, but this is not expected to have a noticeable effect on the aquifers, particularly if wells are completed so as to impede downward leakage. The minor amount of interformational leakage that would occur prior to cementing is not likely to deplete the upper aquifers. If, however, phase II coreholes (where no commercial quantities of tar sand are encountered) are not plugged in such a manner so that downward leakage cannot occur, continuing downward leakage could have minimal to moderate effects on aquifers. The rate of downward leakage (ranging from up to 1 gpm to perhaps 10 gpm per well) could be sufficient to diminish flows from springs and seeps that issue from the base of the Wingate sandstone or older units, particularly in the headwaters of French Spring and Happy canyons (see figure 44 for a depiction of formations and aquifers that could be affected).

During phase IV, potential effects on the character of the subsurface formations and on groundwater could result from the induced fracturing of wells, steam injection, and any uncontrolled excursions of steam-hydrocarbon mixes from the production zone to aquifers above or below the tar-bearing zone in the White Rim sandstone. Drilling would temporarily open a hydraulic connection between any aquifers above the White Rim sandstone. This temporary connection would be eliminated after casing is set and cemented. However, the potential for downward leakage from drilling up to 1,000 wells per square mile could be significant. Assuming that each well would drain downward at a rate of 1 gpm for one day during construction, about 2,880,000 gallons per square mile would be drained from upper perched aquifers (probably in the Navajo, Kayenta, Shinarump, and Moenkopi formations) and recharged to the lower Moenkopi and White Rim. Such depletion of the upper zones could affect flows in existing springs and seeps on or near the mesa top.

Induced fracturing of a selected section of the tar-bearing zone in the White Rim would be required to provide adequate connection between the injection and producing wells. Technology for controlling the extent and orientation of pressure-induced fractures so they do not extend out of the tar-bearing zone is uncertain (USDI, GS 1982a). Large-scale cross-bedding and vertical fractures occur in the outcrop of rocks of the White Rim sandstone in the Elaterite Basin east of the area, and through-going fractures have been mapped in the proposed phase IV production area (Huntoon, Billingsly, and Breed 1982). Such features would tend to lead horizontally induced fractures from the desired horizontal plane into the vertical plane (USDI, GS 1982a). In the Elaterite Basin, both the upper and lower limits of the exposed tar-saturated zone in the White Rim are locally very irregular. If these irregularities also occur in the White Rim in the production area, there locally could be insufficient tar-saturated

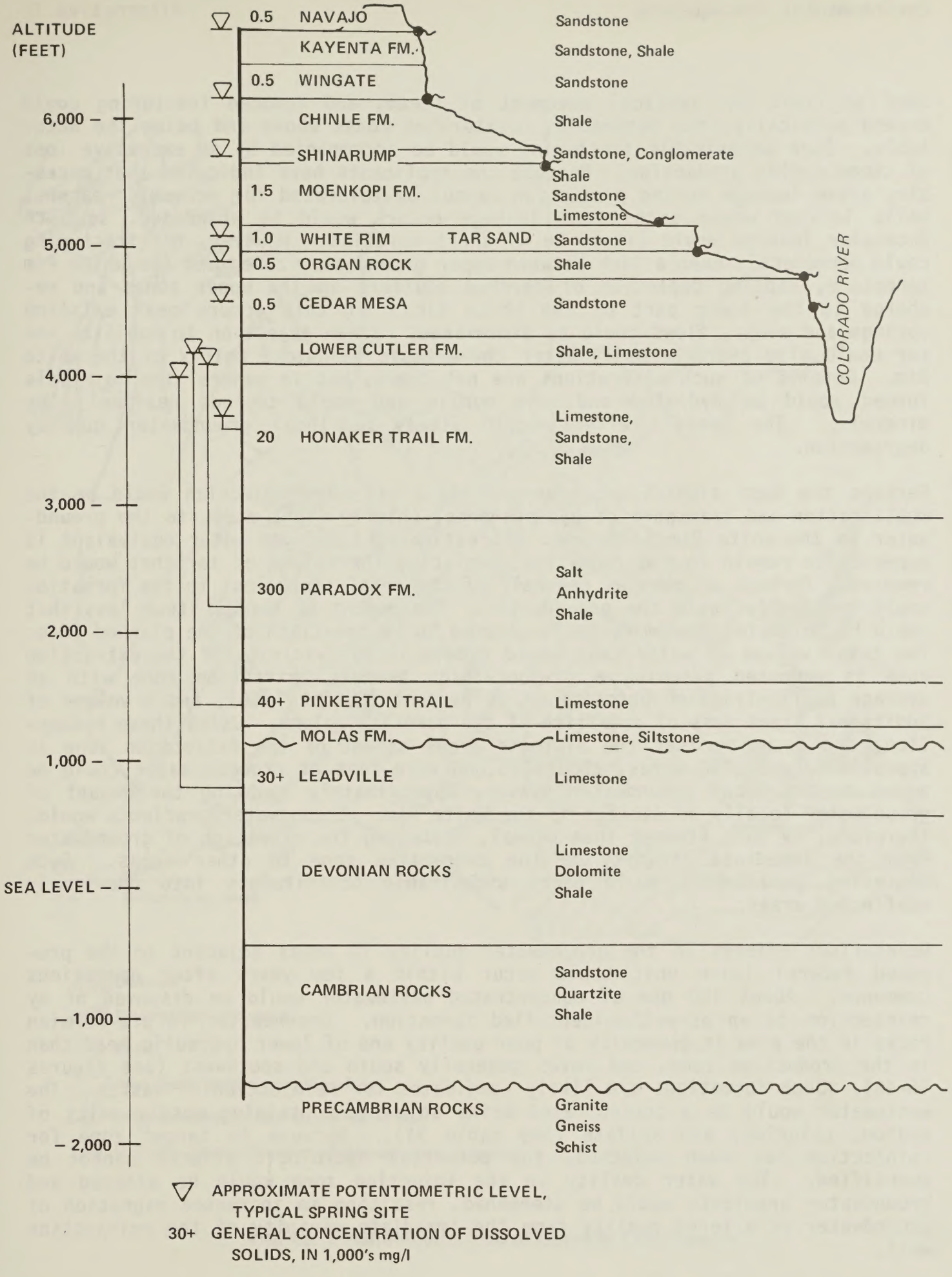


Fig. 44. Hydrologic-Stratigraphic Section
Tar Sand Triangle (Southeast Utah)

sand to limit the vertical movement of steam, and induced fracturing could extend vertically into permeable, unsaturated zones above and below the water table. Such undesirable fracturing would be accompanied by an excessive loss of steam during production. Because the applicants have indicated that excessive steam leakage during production cannot be tolerated for economic reasons, wells located where such steam leakage occurs would be abandoned, so such excessive leakage would likely be of short duration. However, the fracturing could permanently open a link between upper groundwater zones and the White Rim sandstone, causing depletion of perched aquifers in the upper zones and recharge to the lower part of the White Rim. If this occurs near existing springs and seeps, flows could be diminished. Steam injection to mobilize the tar would also hydrothermally alter the arkosic sandstone matrix of the White Rim. Details of such alterations are not known, but in general the materials formed would be hydrated and more mobile and would include residual clay minerals. The overall effect would likely be local groundwater quality degradation.

Perhaps the most significant adverse effect of steam injection would be the mobilization and transport of hydrocarbons, chiefly light ends, to the groundwater in the White Rim sandstone. An estimated 1,050 gpm water equivalent is expected to remain in the formation, replacing the volume of tar that would be removed. Perhaps as much as one-half of the total steam lost to the formation would eventually reach the groundwater. The amount of excess steam loss that could be tolerated economically is assumed to be one-fifth of the planned loss. The total volume of water that would remain in the vicinity of the extraction zone is computed assuming a 42-foot-thick average extraction zone with an average post-extraction porosity of 15 percent (Schick 1966), and a volume of additional steam loss of one-fifth of the porosity volume. Using these assumptions and assuming that the ultimate areal extent of the extraction zone is approximately 38,790 acres, about 145,000 acre-feet of process water could be added to the local groundwater system, approximately doubling the amount of groundwater locally in storage in the White Rim. Groundwater gradients would, therefore, be much steeper than normal, hastening the migration of groundwater from the immediate vicinity of the extraction zone to other areas. Such migrating groundwater could carry undesirable constituents into previously unaffected areas.

Deleterious effects on the groundwater quality in areas adjacent to the proposed federal lease unit could occur within a few years after operations commence. About 150 gpm of concentrated wastewater would be disposed of by reinjection to an as-yet unidentified formation. Groundwater in pre-Permian rocks in the area is generally of poor quality and of lower hydraulic head than in the production zone, and moves generally south and southwest (see figures 45-48). Such formations are likely candidates for reinjection of wastes. The wastewater would be a concentrated brine solution containing mostly salts of sodium, chloride, and sulfate (see table 31). Because no target zone for reinjection has been selected, the potential hydrologic effects cannot be quantified. The water quality in the injection zone would be altered and groundwater gradients would be steepened, resulting in increased migration of groundwater of altered quality from the immediate vicinity of the reinjection well.

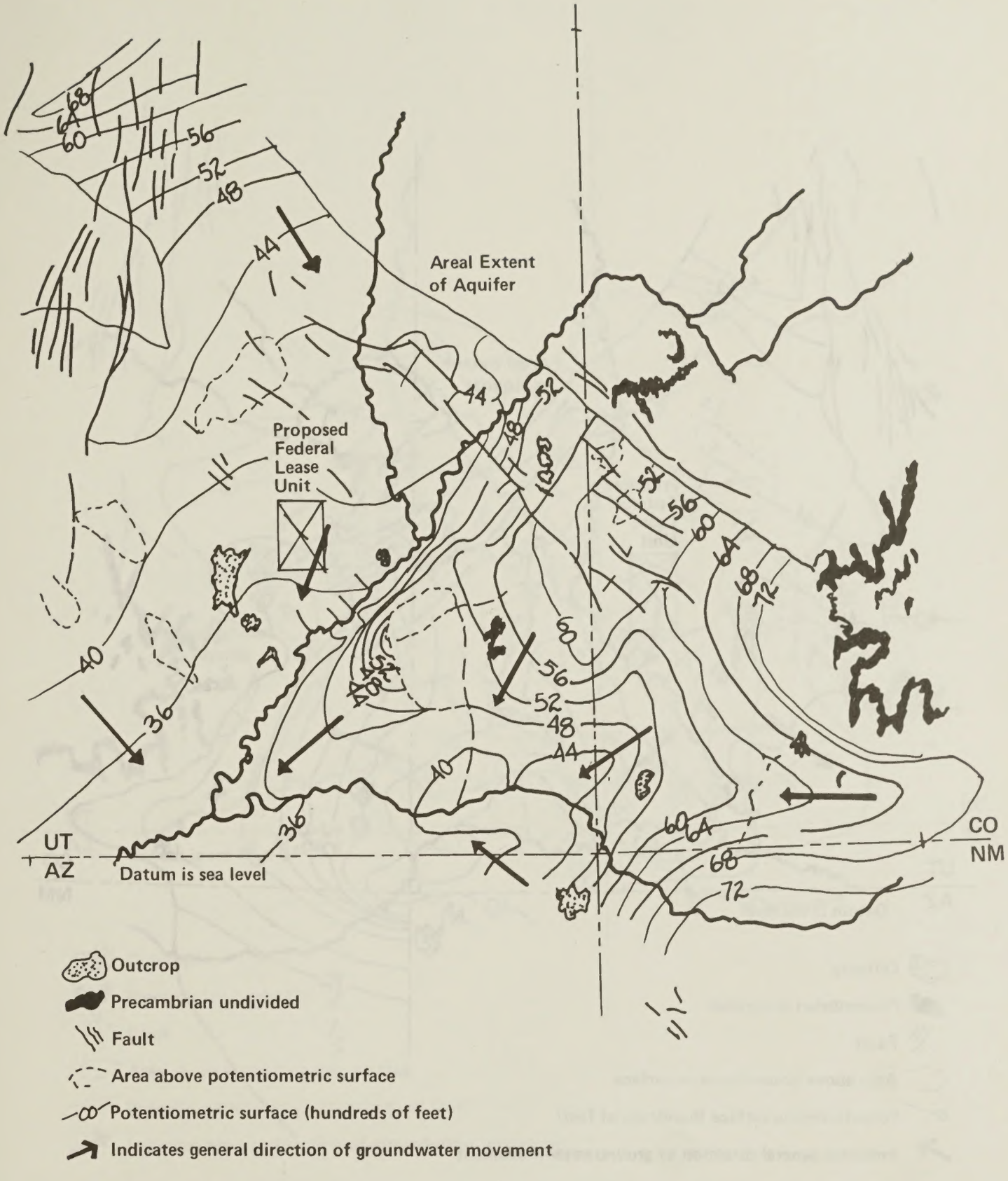


Fig. 45. Potentiometric Map of Honaker Trail Member

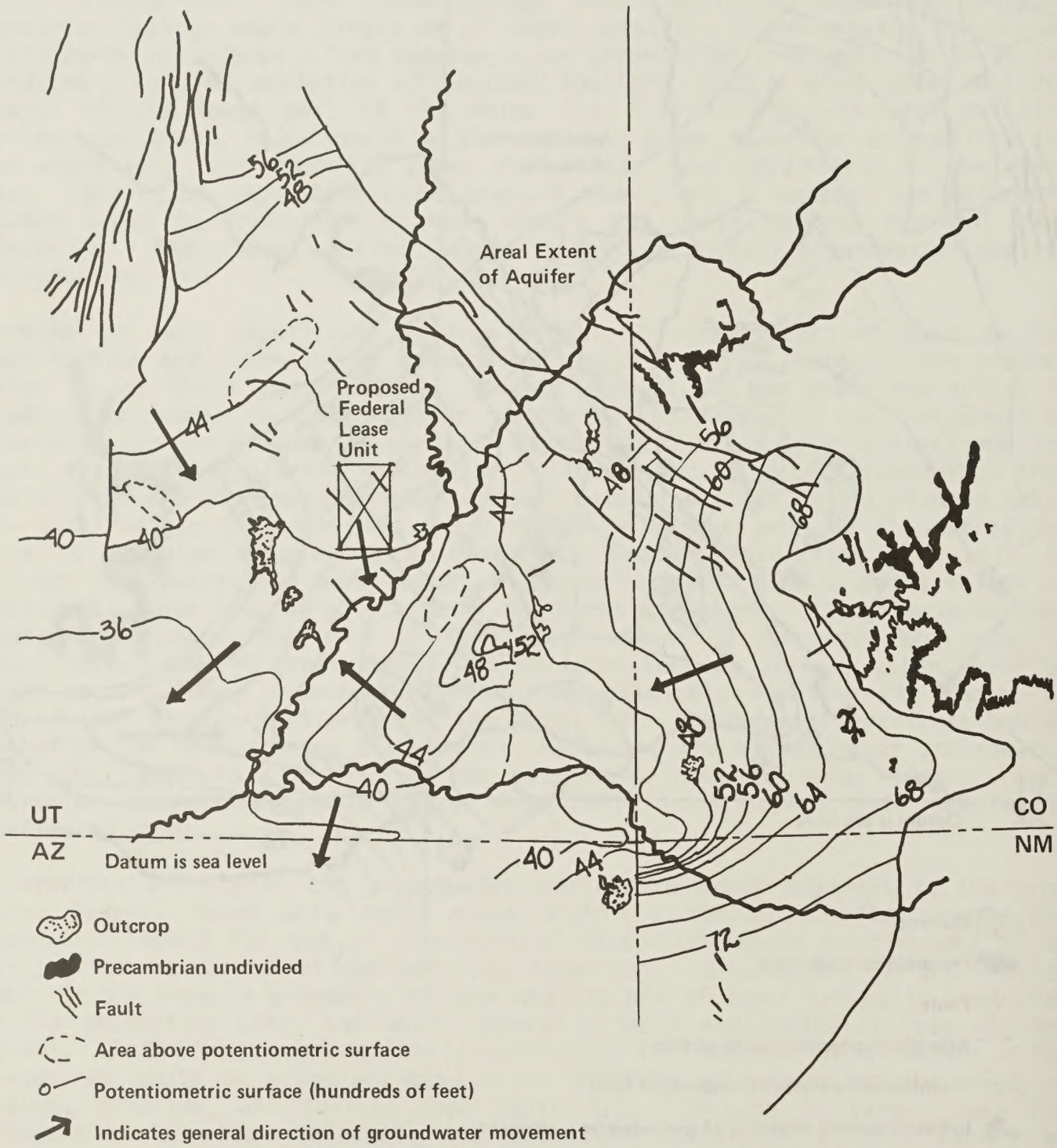


Fig. 46. Potentiometric Map of Mississippian (Leadville) Member

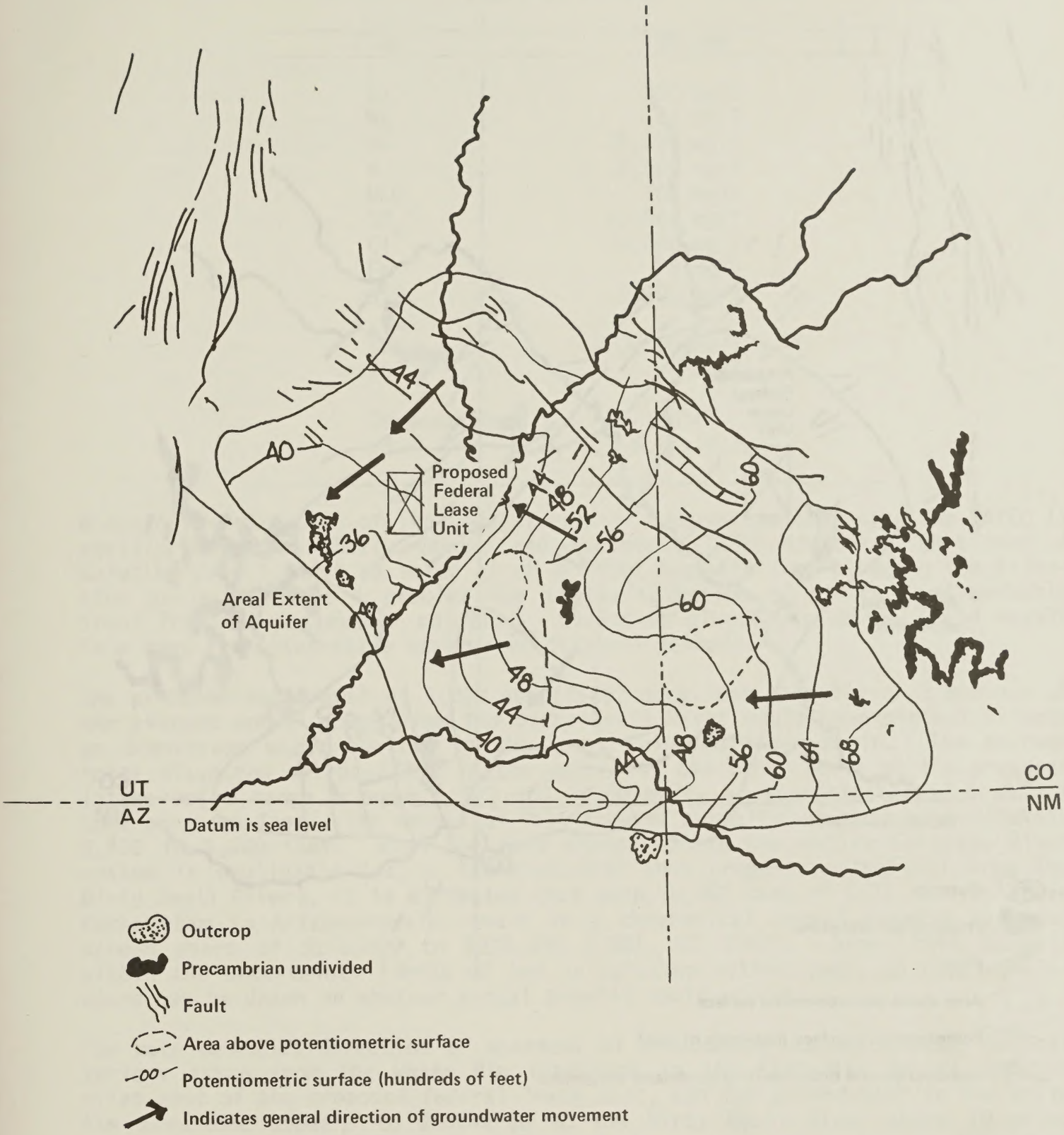


Fig. 47. Potentiometric Map of Paradox Member

Fig. 48. Potentiometric Map of Pinkerton Trail Member

Table 31: Projected Water Quality of Wastewater to be Injected (Maximum Values)

Flow	150 gpm
Ca	100 mg/l
Mg	75 mg/l
Na	75,000 mg/l
K	2,500 mg/l
HCO_3	100 mg/l
SO_4	50,000 mg/l
Cl	75,000 mg/l
Fe	75 mg/l
SiO_2	5,000 mg/l
TDS	200,000 mg/l
TSS	5 mg/l
Temperature	150°F
pH	6.0 - 8.5

A cursory examination of the constituents of the wastewater using the WATEC II equilibrium model (Ball, Jenne, and Nordstrom 1979) indicates that such a solution cannot exist as noted at pH 8.5 and suggests that plugging the injection wells could be a problem due to precipitation of silica (and probably iron) from the wastewater solution. Excessive plugging problems could result in a need for alternative wastewater disposal methods.

The proposed withdrawal of 1,050 gpm (1,697 acre-feet annually or 3 percent of the average annual flow) from the Dirty Devil River would have minimal effects on downstream water quality in the lower Colorado River Basin. The average total dissolved solids (TDS) in the waters of the Dirty Devil at the proposed intake point range between 1,500 and 2,000 mg/l, or approximately 2.0 to 2.7 tons per acre-feet. The amount of salt removed annually would be approximately 3,400 to 4,600 tons. When the flow change within the entire Colorado River system is negligible (as is the case with this proposed withdrawal from the Dirty Devil River), it is estimated that each 10,000 tons of salt removed above Parker Dam in Arizona would result in a theoretical annual benefit to downstream users of $175,000 to $235,000 (USDI, GS 1983). Since this is well within the uncertainty limits of the calculation method used, no firm conclusions can be drawn on whether a real benefit would accrue.

The rate or exact direction of movement of groundwater is not known. Several springs issue from the White Rim sandstone in the Elaterite Basin, about 5 miles east of the proposed federal lease unit, and the groundwater in the White Rim sandstone appears to discharge to the Dirty Devil River about 10 miles southwest of the proposed unit. Both discharge points are downgradient from the proposed extraction zone, and the gradient would increase with the amount of water added during steam extraction. Water quality would eventually be adversely affected in these discharge areas, but such effects may not occur for decades or even centuries after tar sand operations are completed.

The long-term effects of a large mass of heated rock beneath the area after operations cease cannot be quantified. An obvious effect would be an increase in the temperature of any groundwater that is in proximity to the heated areas and thus an increase in flow velocities.

Limited evidence indicates that there is a downward groundwater gradient from the White Rim to the Cedar Mesa sandstone. The Cedar Mesa sandstone is the source of the water in the NPS well at the Hans Flat ranger station. The Organ Rock shale beneath the White Rim and above the Cedar Mesa sandstone should impede any downward flow of process water, but adverse effects on the quality or quantity of water in the well could occur.

Soils

The primary soil disturbance during phase I would occur during construction of the two coreholes at Gordon Flats. Total surface disturbance would be approximately 1 to 2 acres. Both sites are accessible from an existing road, so little or no additional surface disturbance due to road access is anticipated. The area is nearly flat, sloping gently to the west. Soil loss from runoff would be similar to that occurring on natural areas surrounding the drill pads. The potential for wind erosion is high in this area because of the Begay soils present; however, because little vegetation would be removed, erosion should be minimal. After drilling operations are complete, the companies would scarify the drill pads (if necessary to reduce compaction) and reseed the pads with approved vegetation species.

Phase II operations would result in the disturbance of approximately 15 acres of soil and vegetation for the drill pads. Additional acreages of soils would be disturbed by constructing up to 12 miles of new roads into the drill sites. The potential loss of soil at most of the drill pads and from new roads would be minor and generally comparable to natural levels of soil erosion on adjacent, undisturbed areas. Disturbance for drill pads and roads would be minimized wherever possible by choosing pad locations that are relatively flat and require little additional clearing, leveling, or filling. Permanent roads would not be constructed, and leveling, clearing, and blading sufficient to prepare access for a truck-mounted drill rig would be kept to a minimum.

However, 4 of the 15 proposed phase II corehole sites could have potential for increased soil erosion. Corehole #1 (see figure 6 in the "Alternatives Including the Proposed Action" section) is located within a shrubland area with Begay soils that has active dune sand. Approximately one-half mile of the access road to this well site also passes through a highly erodible soil zone. Corehole #3 is located on similar soils and would experience the same problems over three-quarters of a mile of its access road.

Corehole #15 is located on the south flank of Gunsight Butte, in the southern portion of the proposed unit, and would require approximately 1¼ miles of new access, which would follow a bench along the base of the butte and cross drainages at right angles. Larger gullies would require cuts-and-fills. Due to the steep slopes and relatively large drainages, an undetermined amount of erosion loss would occur. If the roadbed is not closed when drilling is completed, erosion would continue and result in gully washouts and downcutting on the roadbed and deposition of eroded materials downdrainage.

Corehole #11, located in Happy Canyon, is not easily accessible from the Big Ridge. The existing primitive road off the top of Big Ridge near Flint Seep into the canyon would require extensive upgrading to make it passable by trucks. Even if the road were upgraded, the grade is so steep that the large trucks required to transport drilling equipment could not use it. An upgraded road in this area would require extensive maintenance and could cause excessive downdrainage erosion if not properly closed and reclaimed. Corehole #11 is also accessible via an existing trail from the west, and use of this route could be less environmentally damaging and less expensive to improve and maintain than the route from the top of Big Ridge proposed by the applicants.

Phase III construction activities would disturb approximately 15 acres of soils and vegetation. The pilot plant facilities would be located at Gordon Flats, largely on fine sandy loam soils of the Begay series (see figure 44).

Depending upon site-specific engineering properties of the soils, the access road to the pilot facility, as well as the existing Flint Trail, could require upgrading. At a minimum, crowning and drainage improvements would be required, and paving could be proposed as a method of reducing dust and road maintenance problems. Existing roads in the area, including the Flint Trail, tend to downcut, gully longitudinally, wash out in crossdrainages, and drift in with blowsand. Such effects are detrimental to attempts to keep access open, and also cause detrimental downdrainage effects such as sedimentation and increased erosion due to water channeling and velocity increases.

Constructing the extraction and upgrading facilities proposed as a part of phase IV operations would have severe impacts on the quantity and quality of the soil cover. The severity of the impacts depends upon the exact location and configuration of the extraction and upgrading facilities and associated roads, waste disposal areas, and stockpiles. Under this alternative, 54,546 acres would be available for development and subject to some surface disturbance. However, since the major development activities would take place on the 18 prospective areas, only 11,953 acres of soils would be completely disturbed (see table 32), but some disturbance on the remaining 17,929 acres within the extraction zones could also be expected. Other acreages outside the 18 prospective areas could also experience disturbance from pipeline construction and road building, however, the amount of disturbance cannot be quantified at this time.

Prior to construction, a soil engineering study would be conducted to determine the load-bearing and other engineering characteristics of the soils; it would then be determined what soils must be removed and stockpiled and which would be used in the construction of wellpads, roads, and other facilities. If all of the soil is removed to bedrock wherever soil disturbance is necessary within each of up to 18 extraction zones and is stockpiled, as proposed by the applicants, assuming an average soil depth of 1 foot and a bulking factor of 0.3, approximately 750,000 cubic yards of topsoil would be stockpiled onsite for each prospective area. Assuming a stockpile height of 50 feet, approximately 19 acres of storage space would be required to stockpile the soil.

Table 32: Disturbance by Soil Series

Soil Series	Acres Subject to Development	Net Acres Disturbed
Begay	3,243	1,297
Rizno (Channery)	3,110	1,244
Rizno (Warm)	1,822	729
Mellenthin	16,372	6,549
Arches	1,831	732
Travessilla	2,774	1,110
Mido	607	243
Farb	74	30
Otero	18	7
Badland	31	12
Total	29,882[1]	11,953[2]

[1]Acres of soil within prospective areas #1-#17, #22, and a portion of #23 only.
[2]Acres of soil significantly disturbed or removed by operations using a 40 percent disturbance factor.

The texture and structure of the soils would be disrupted by stockpiling. For soils found within the proposed federal lease unit, the adverse effects on soil structure are minimal because of poor development of distinct horizons or physical structure. A potentially more significant effect of stockpiling is the effects on the mycorrhizal potential of the stockpiled soil and its ability to support revegetation. The exact correlation between depth and age of stockpiles and mycorrhizal infection potential has not been established, but evidence suggests that storage time in excess of four or five years significantly reduces the number of mycorrhizal propagules present (Singleton and Williams 1979).

The effects on soils are related to their geotopographic location. Effects on mesa top soils, such as those atop the Big Ridge and near Twin Corral Flats, would differ from effects on canyon bottom soils. The mesa top soils, such as those in Twin Corral Flats (principally Begay and Mido soils), are especially susceptible to wind erosion. Mesa top soils are aeolian (wind-deposited) and, once exposed due to vegetation removal, are easily eroded and transported by winds. By contrast, water erosion is the greatest threat to canyon bottom soils, particularly the Channery fine sandy loams of the Rizno series that are most common in the Sunset Pass area (see figure 54).

In particular, road development and wellpad construction on the talus slopes at the base of the canyon walls would substantially increase runoff and erosion. The steep slopes would necessitate large cuts-and-fills for successful construction of roads and pads, and these areas would be difficult to stabilize. Soil in the drainages and canyon bottoms was originally water-deposited, and, once disturbed, is easily water-eroded and carried downdrainage.

The Gordon Flats area where phase I and III activities are proposed has approximately a 1 percent cryptogamic crust cover. This cover increases to approximately 5 percent (based on preliminary survey information) in areas where phase II coreholes are proposed. Disturbance of these crusts would increase wind erosion on those areas disturbed. Regeneration of cryptogamic crust is estimated to take approximately 20 years if proper soil conditions are reestablished after operations are completed.

On the average, cryptogamic crusts cover an estimated 5 percent of the mesa top soils, and 11 percent of canyon bottom soils The cryptogamic crusts would be destroyed by phase IV construction and operation of the extraction zones, upgrading plant, roads, and associated facilities. Loss of the crusts during construction and operations, however, makes the surface soils much more vulnerable to wind and water erosion. Also, high sulfur dioxide air emissions from extraction and processing activities could cause a reduction in the amount of lichens that form the crusts. This reduction would be widespread and not limited to the extraction zone (Bennett, pers. comm., NPS 1983). It is not known just how this would affect the integrity of the crust or its soil-binding abilities.

Phase III drill hole cuttings would be disposed of in a pit onsite or would be distributed in a thin layer over the drill pads. The cuttings would be sandy and similar in character to the soils present onsite. Water erosion of exposed soils is not expected to occur in noticeable amounts, but detrimental amounts of wind erosion could occur. Use of a chemical soil binder could become necessary to prevent excessive amounts of windblown dust.

Completion of each of the phase IV wells would yield an average of 26 cubic yards of drill cuttings to the top of the White Rim formation, and the White Rim formation would yield an additional 2½ cubic yards of cuttings. The estimated total volume of 990,000 cubic yards of cuttings for each of the prospective areas would cover 2 acres to a depth of 50 feet. Disposing of the volume of cuttings in pits, as proposed in the plan of operations, would be difficult due to the shallowness of the soil cover in many parts of the proposed federal lease unit. Cuttings from above the White Rim could be disposed of by spreading them out over the entire wellfield acreage (if the cuttings were evenly distributed in a 2-inch layer, they would ultimately cover approximately 3,680 acres) or mixing them with the stockpiled soils. Cuttings from intervals above the White Rim would likely be innocuous and of similar mineral content as the native soils. However, cuttings from the White Rim would probably contain hydrocarbon constituents that could inhibit soil fertility, and they could not be disposed of by spreading over the soil surface. In all cases, the cuttings would decompose to very fine particulate matter, and, if not properly disposed of and stabilized, would be very susceptible to wind and water erosion.

Reclamation would be difficult in all areas of the lease unit, as the soils affected are rated as either poor or very poor in suitability for seeding or planting (USDI, SCS 1983). The main limitations are shallow sandy soils, low fertility, and water availability. Reclamation of disturbed sites could be possible but would require careful planning and intensive, long-term efforts to ensure success.

Vegetation

Approximately 1 acre of sagebrush would be removed at each of the two coreholes during phase I. This small disturbance would not affect the existence or abundance of the sagebrush shrubland vegetation type located in the area. No threatened and endangered plant species have been found at the proposed drilling sites, and suitable habitat for protected species is not known to exist at the sites.

Approximately 15 acres of vegetation, mostly pinyon-juniper, would be disturbed during phase II. Some herbaceous and shrubby vegetation would be lost on the drill pads. Vegetation loss along new access roads would be minimal, because roadwork or access trail upgrading would be kept to a minimum. Tree removal would be avoided wherever possible, but the destruction of some individual pinyon or juniper trees cannot be avoided. This loss would not affect the existence or abundance of the pinyon-juniper vegetation type.

During phase III, all vegetation would be removed from a 4- to 8-acre area to permit setting of equipment and to reduce fire hazard. Additional vegetation would be removed or disturbed on up to 15 acres, as necessary, for testing facilities, wellfields, and road access. The principal vegetation type affected would be sagebrush shrubland.

The amount of sagebrush, pinyon, and juniper and other vegetation removed at this site is not expected to affect the viability of these vegetation types within the proposed federal lease unit. The effects of vegetation removal would be mitigated by reclamation and revegetation efforts after pilot phase activities are completed and the site is abandoned, but soils and vegetation in the vicinity of the phase III activities range from poor to very poor in reclamation potential (USDI, SCS 1983). Disturbed sites in the pinyon-juniper/shrub vegetation type shows very little natural revegetation. Because the site partially lies on shallow, sandy soils, suitability for successful reseeding is very poor (USDA, SCS 1983).

Once established, however, it is estimated that shrub and grassland can be restored within 5 years, while pinyon-juniper could be restored to the mature stage in 60 to 70 years. Temporary fencing of the site to exclude cattle would enhance the likelihood of reclamation success.

Constructing the phase IV upgrading facilities would destroy all vegetation on the 40-acre site, principally pinyon-juniper woodland, for the life of the project. Developing the initial extraction zone (prospective area #1) would require directly removing up to a minimum of 40 percent of the vegetation at the Gordon Flats site, including 400 acres of pinyon-juniper woodland and 161 acres of sagebrush shrubland.

Approximately 37 acres (assuming a 15-mile corridor, 20 feet wide) of various types of vegetation would be disturbed for the water supply pipeline from the Dirty Devil River. Constructing roads, ancillary facilities, and product pipelines would also result in the destruction of additional vegetation. The amount of vegetation removed would depend upon the terrain and the particular vegetation type present in the as-yet unselected areas for these facilities.

No threatened or endangered plant species were found during 1982-83 preliminary vegetation surveys, but no intensive, site-specific surveys for threatened and endangered plant species have been done. Smith's eriogonum is restricted to the red selenium-rich blow sands of the San Rafael desert, and few suitable habitat areas for this species exist within the proposed federal lease unit. Drake scorpionweed and the endangered Wright's fishhook cactus could occur in the lease area, since the Chinle formation provides suitable conditions for these species, but no specimens of either of these two species have been found. As development progresses throughout the lease unit, the possibility of affecting as-yet undiscovered threatened or endangered plant populations increases. However, a site-specific threatened and endangered species inventory would be required prior to approval of any surface-disturbing activities.

Approximately 35,839 acres of vegetation would be subject to disturbance from development activities over the life of the project within the 18 extraction zones. Of this acreage, it is anticipated that 40 percent of the area within each extraction zone would be totally modified for production purposes, resulting in the complete removal of all vegetation on 14,335 acres. Table 33 summarizes this disturbance by vegetation type.

Table 33: Disturbance by Vegetation Type

Vegetation Type	Acres Subject to Development	Net Acres Subject to Removal
Badlands woodland	334	134
Blackbrush shrubland	718	287
Pinyon-juniper shrub/woodland (blackbrush zone)	6,077	2,431
Pinyon-juniper shrub/woodland (sagebrush zone)	4,423	1,769
Pinyon-juniper woodland	19,702	7,881
Sagebrush shrubland	2,422	969
Slickrock woodland	701	280
Slope vegetation	1,451	580
Canyon riparian	11	4
Total	35,839[1]	14,335[2]

[1]Acres of vegetation type within prospective areas #1-#18, #22, and #23 only.
[2]Acres significantly disturbed or removed by operations assuming a 40 percent disturbance factor.

Wildlife

During phases I, II, and III a minimal amount of habitat would be lost. Small local populations of birds, small mammals, reptiles, and invertebrates could be

affected, but such effects are expected to be transitory and not threaten the continued existence of any of these populations.

The nonimpairment standard for WSAs would provide protection of habitat within the WSAs from intense development activities until such time as Congress acts to drop the WSAs from consideration as wilderness; if the areas are dropped from consideration, full development (subject to restriction to protect sensitive resources) could occur, with consequent habitat degradation for all species.

The impact of phase I activities on the desert bighorn sheep would not be significant. The well locations as shown are more than one-half mile from the mesa rims and are far enough from escape terrain so that the activity would have little effect on the bighorn habitat. Although bighorn rams could occasionally stray more than one-half mile from escape terrain, any displacement of such rams would be speculative and cannot be considered significant. The proposed test well locations are near the Flint Trail, an earlier existing human intrusion for this sensitive species; drilling of the coreholes would not significantly increase the amount of human intrusion. Drilling noise could have a minor effect on the bighorns and cause some displacement. The minimal extent of these impacts would not adversely affect the planned reintroduction of bighorns to the area.

Minor to moderate adverse effects on bighorn sheep could occur due to phase II drilling activities. Several of the 15 proposed drill sites are located within desert bighorn sheep range near the rims, therefore, near critical escape terrain (see figure 31). As more holes would be drilled in more remote areas during this phase than during phase I, the likelihood of sheep disturbance is increased. Any sheep in the vicinity of the drilling operations would be disturbed by noise and human activity. The adverse impacts of even temporary displacement on a population of such low numbers could be significant. Reintroducing bighorn sheep into the area would probably be precluded for the duration of the drilling activities. The effect of human activities on animals recently stressed by handling (in transplanting) would be detrimental (Wylie, pers. comm., NPS 1983).

The adverse impacts on bighorn sheep during phase III could be greater than for phase I but less than for phase II. Locating the pilot facility near the rims and above preferred habitat areas lying below the rims would displace bighorn sheep in the vicinity. The degree of displacement would depend upon the behavioral patterns of the sheep and on the distance to the nearest acceptable alternate habitat. The minimum distance of displacement would likely be one-half mile. Locating the extraction area at least one-half mile from the rim would minimize or eliminate adverse impacts on bighorns. Phase III activities would not be as likely to disrupt the transplanting activities so long as an acceptable transplant site could be identified in an area well away from the pilot facilities.

The magnitude of activities occurring as a part of phase IV development would likely displace bighorn sheep from the area and bring on stress-related diseases within the herd. There is little likelihood that such a small population of bighorn could develop the tolerance and resilience needed to survive the adjustment period. Activities at or near water sources could severely affect the sheep. The downward leakage resulting from the wellfield development could adversely affect flows to springs and seeps now available for use by

bighorn sheep and other wildlife. Reintroduction efforts designed to assist population recovery from critically low levels would be at risk or would be totally infeasible for the duration of the phase IV activities (up to 160 years).

In the immediate area of phase I and III activities, an inactive buteo hawk or raven nest was found approximately three-quarters of a mile east-southeast of the proposed corehole drilling sites, and a falcon scrape was noted about 1 mile northeast of the sites (Joseph, FWS, pers. comm. 1983). The type of falcon associated with the scrape is not known. Though prairie and peregrine falcons could occur in the area, the level of activities proposed for phase I is unlikely to have adverse effects on these and other raptors.

Because phase II activities would occur at up to 15 dispersed locations within the proposed unit, the possibility of disturbance to raptor populations is enhanced. However, phase II activities are of limited duration, and if activities can be avoided within 3,200 feet (1 km) of an active raptor nest during the nesting season (end of February to the end of June), adverse impacts would be minimized.

Although the plan of operations presented by the applicants does not propose complete denudation of the extraction zones during phase IV, the presence of closely spaced wells and ancillary equipment would essentially destroy the area as habitat for wildlife for the entire area, even though all vegetation is not physically removed. Some small species, such as rodents and rabbits, could probably manage to survive in reduced numbers in this degraded habitat, as would some bird species. Larger species would likely avoid the area completely. Although this would probably not affect the continued viability of the larger species on a regional basis, eliminating these species would conflict with NPS management objectives of maintaining natural processes for the enjoyment of recreation visitors to Glen Canyon National Recreation Area and Canyonlands National Park.

The habitat disturbance would proceed incrementally as the wellfield is rolled and as development progresses throughout the proposed federal lease unit. As the tar sand resource is depleted, the exhausted areas would be reclaimed, creating new habitat for wildlife. Even though the net active disturbance would be limited to an average of approximately 1,400 acres at any one time (or 0.4 percent of the unit), the vegetation composition, wildlife habitats, and wildlife species would be much different on reclaimed versus undisturbed areas. The new plant cover on reclaimed areas would be mostly grasses, forbs, legumes, and young shrubs and trees rather than mature sagebrush and pinyon-juniper trees, which would favor those animal species who prefer habitat composed of early seral stages, such as deer and rabbits, rather than species preferring (or restricted to) mature vegetation types.

Burros inhabit the Millard Canyon area on occasion, but, because no project activities are proposed within their range, no direct impacts on burros are anticipated. Secondary or indirect effects (such as harassment) could occur, but cannot be quantified at this time.

Two golden eagle nests are near proposed access roads. The Eagle Protection Act prohibits activities within 3,200 feet (1 km) or less of nests during the nesting season.

The endangered northern bald eagle is a winter resident of southeastern Utah, but has not been identified in the proposed unit. The bald eagle is normally restricted to riverine areas such as the Green and Colorado rivers to the south and east of the proposed unit and to the shoreline of Lake Powell (USDI, BLM 1982; UDWR 1980) and is not likely to be affected by activities within the lease unit. Future offsite activities, such as constructing water or product pipelines, could affect the bald eagles in the area if such activities occur in proximity to the Colorado or Green rivers.

Raptors protected under the Migratory Bird Treaty Act, such as the red-tailed hawk, would require protection from vehicular traffic or other activities within a range of 3,200 feet (1 km) during their nesting seasons in the spring and early summer. Several species of birds listed as sensitive species or of high federal concern also are known to occur in the vicinity of the proposed unit (see appendix F). Individuals of these species could be adversely affected by phase IV activities, but the exact effects on individuals or on the occurrence and viability of these species cannot be quantified based on the limited survey information available.

No threatened or endangered wildlife species are known to inhabit the proposed federal lease unit. Of the species listed for the area, the endangered peregrine falcon is the most likely to occur within the lease unit. Although no falcon eyries have been found within the unit to date, the Orange Cliffs (on the eastern edge of the proposed federal lease unit) area is considered to be potential habitat for the peregrine (Joseph, FWS, pers. comm. 1983). Other cliff faces within the proposed unit could also provide suitable peregrine habitat, but the probability of peregrine occurrence within the unit is considered to be relatively low because of the lack of perennial watercourses and adequate prey base in the area. Restrictions on project activity within 3,200 feet (1 km) of active nesting areas would minimize any potential adverse effects.

The applicants propose to obtain water for steam generation and other onsite processing needs from the Dirty Devil River to the west of the proposed unit. Withdrawals from the Dirty Devil could adversely affect the viability of the razorback sucker, a fish species proposed for listing as an endangered species (Clark, FWS, pers. comm. 1983). In addition, the FWS considers any reduction of flows in the upper Colorado River Basin as potentially damaging to the threatened and endangered fish species of the Colorado River drainage. The status of the endangered Colorado squawfish and humpback chub would be considered as threatened by any water removal from the Dirty Devil River sufficient to reduce flows (Bohlwahnn, FWS, pers. comm. 1983), but because the amount of water that would be removed from the upper Colorado basin would probably not impair flows in the lower Colorado basin, such impacts are not anticipated.

Present project descriptions do not contain sufficient information to make a full determination whether or not the eventual development of any of the potential leases would jeopardize the continued existence of any threatened or endangered species. This is particularly true for water use from the Colorado River system in relation to endangered fish species. Therefore, it may be necessary for BLM or NPS to request section 7 (Endangered Species Act) consultation with the FWS on a phase-by-phase basis as each phase of the plan of operations is reviewed for approval. If leases are converted, each lease would contain the following special provision in order to avoid a section 7 jeopardy biological opinion:

The lessee shall develop a plan of operation which will fully protect threatened or endangered species and shall submit the plan to BLM for formal consultation with FWS as required by section 7 of the Endangered Species Act. Consultation must be completed prior to the irreversible or irretrievable commitment of resource or funds for "on-the-ground" development.

This lease is issued and accepted with the express agreement that such consultation may require adjustments to the plan of operation, addition of special conservation measures, or limitations to the project in order to assure compliance with such provisions of the Endangered Species Act as may be applicable at the time of development as determined by FWS.

Air Quality

This section discusses the potential impacts on air quality attributable to the proposed development and the consequences, if any, of these impacts. The framework for the organization of this section is based on present state and federal air quality regulations, focusing on: national ambient air quality standards; prevention of significant deterioration, specifically the class I and class II increments for particulate matter and sulfur dioxide; and effects on air quality related values (including visibility).

The pollutant concentrations needed to address these areas were estimated with air quality dispersion models using emissions, meteorological, and topographic data. Annual concentration estimates for sulfur dioxide, particulate matter, and nitrogen dioxide were made using the LONGZ model. Short-term concentration estimates for these pollutants were made using the SHORTZ model. Both models are modified to account for the effects on ambient particulate concentration of gravitational settling and dry deposition. Estimates of annual average sulfate deposition are made with the ISCLT model using a sulfur-dioxide-to-sulfate conversion rate of 0.5 percent per hour.

The detailed description of the models used, the justification for their selection, and the evaluations of model performance are presented in "Pollutant Concentration Estimates for the Proposed Utah Tar Sand Triangle Project" (H.E. Cramer Company, Inc. 1983). Every attempt was made to comply with the Environmental Protection Agency (EPA) modeling guidelines. Where nonguideline techniques were employed, justification for their selection is given. In the case where no guidelines are available for a particular impact assessment (e.g., sulfate deposition), the assumption made was documented.

Although the form of the short-term NAAQS and PSD increments allow one exceedance of the level of the standard or increment, EPA requires that the maximum modeled concentration estimates, rather than the highest-second-high estimates be used for judging compliance with the standards or increments when less than five years of representative meteorological data or less than at least one year of onsite data are available. Since no onsite data were available and since less than five years of representative meteorological data were available for the proposed federal lease unit, only maximum concentration estimates were used in these analyses and for comparison with NAAQS and PSD increments.

Because the potential air quality impacts of phases I and II are assumed to be insignificant and short term, this section deals only with air quality impacts associated with phases III and IV.

Phase III. There are differences between the scenario modeled for the DEIS and the phase III scenario eventually presented by the applicants, but these differences do not cause significant differences in the calculated maximum concentrations of air pollutants that could be expected as a result of phase III activities. Estimated pollutant concentrations resulting from pilot operations during phase III on class II areas (Glen Canyon National Recreation Area and adjacent BLM lands) are shown in table 34. The estimates for nitrogen dioxide are based on a total conversion of all nitrogen oxides emissions to nitrogen dioxide. There would be no exceedances of the NAAQS, but the class II 24-hour PSD increment for sulfur dioxide would be exceeded.

While this analysis cannot necessarily be used to draw any conclusions about the likelihood of the project gaining required construction permits, it does indicated that mitigation measures would be necessary before the phase III development could proceed. Possible mitigation measures are suggested by an analysis of some of the emission parameters used in modeling. For example, for purposes of this analysis for the pilot plant operations, a stack height of 5 meters (m) and a fuel oil sulfur content of 0.7 percent was assumed. Because the sulfur dioxide concentrations estimated by the model vary directly with the sulfur content of the fuel used and the height of the boiler stack, adjustments to these parameters may be all that is required to eliminate PSD increment exceedance. Specifically, since there is terrain downwind of the initial boiler locations higher than the stack height modeled, high sulfur dioxide concentrations were noted. However, the applicants could easily mitigate such impacts by installing taller stacks on the boiler (any height up to 65 m is acceptable from a regulatory standpoint). Using a higher grade fuel oil with a lower sulfur content would also minimize adverse impacts due to sulfur dioxide concentrations. If a fuel content of 0.5 percent were assumed, no PSD exceedance would be expected. Therefore, phase III activities are not expected to generate a significant air quality impact if the applicants implement some combination of the above mitigation procedures.

No guideline modeling techniques currently exist for estimating ozone concentrations due to an isolated stationary source of nitrogen oxides and hydrocarbons. (There are some resource-intensive models at the development and testing stage, but there use would be unwarranted in this case.) However, evidence in the literature suggests that if the ratio of ambient levels of reactive hydrocarbons to nitrogen oxides is less than one, the probability of ozone formation is low (Sexton and Westberg 1983). For phase III, the ratio of reactive hydrocarbon to nitrogen oxide emissions is approximately 1.0. Therefore, no substantial increase in ozone concentrations would be expected in either the class II or class I areas near the proposed federal lease unit during phase III.

Table 35 contains a summary of the maximum calculated concentrations of pollutants likely to occur in class I areas as a result of phase III activities. All concentrations are much lower than the applicable increments and standards.

The potential for visibility degradation due to this phase of the project can be estimated using the level 1 screening test. The level 1 visibility screening analysis is a straightforward calculation designed to identify those

Table 34: Pollutant Concentrations Calculated for Phase III Emissions

Pollutant	Averaging Time	Concentration (ug/m^3)					
		Assumed Background*	Project Contribution	Total (calculated)	NAAQS	PSD Increment (Class II)	PSD Increment Exceedance Ratio**
SO_2	3 hours	13	348	361	1,300	512	.68
	24 hours	13	125	138	365	91	1.37
	annual	13	18	41	80	20	.88
Particulates	24 hours	90	25	115	260	37	.68
	annual	19	5	24	100	19	.21
NO_2	annual	13	21	34	100	--	.34

Note: All calculated maximum concentrations are located in Glen Canyon National Recreation Area.

* See table 18.

** Exceedance Ratio = calculated concentration/PSD increment, except for NO_2 where ratio = NO_2 concentration/NAAQS. Ratios greater than one indicate that the increment or standard may be exceeded.

Table 35: Pollutant Concentrations Calculated at Canyonlands, Arches, and Capitol Reef National Parks for Phase III Emissions

Pollutant	Averaging Time	Concentration (ug/m^3) Assumed Background*	Project Contribution	Total	NAAQS	PSD Increment (Class I)	PSD Increment Exceedance Ratio**
Canyonlands National Park							
SO_2	3 hours	13	7.88	21	1,300	25	.32
	24 hours	13	1.11	14	365	5	.22
	Annual	13	0.10	13	80	2	.05
Particulates	24 hours	90	0.45	90	260	10	.05
	Annual	19	0.05	19	75	5	.01
NO_2	annual	13	0.10	13	100	--	.13
Arches National Park							
SO_2	3 hours	13	0.47	14	1,300	25	.02
	24 hours	13	0.07	13	365	5	.01
	Annual	13	0.003	13	80	2	.002
Particulates	24 hours	90	0.03	90	260	10	.003
	Annual	19	0.002	19	75	5	.0004
NO_2	Annual	13	0.02	13	100	--	.13
Capitol Reef National Park							
SO_2	3 hours	13	1.51	14	1,300	25	.02
	24 hours	13	1.07	13	365	5	.01
	Annual	13	0.002	13	80	2	.001
Particulates	24 hours	90	.03	90	260	10	.003
	Annual	19	0.001	19	75	5	.0002
NO_2	Annual	13	0.003	13	100	--	.13

* See table 18.

** Exceedance Ratio = calculated concentration/PSD increment, except for NO_2 where ratio = NO_2 concentration/NAAQS. Ratios greater than one indicate that the increment or standard may be exceeded.

emission sources that have little potential of adversely affecting visibility (Latimer and Ireson 1980). If the source passes the level 1 screening test (a contrast change less than the absolute value of ±0.1), it is not likely to cause visibility impairment, and further analysis of potential visibility impacts would be unnecessary.

Using the estimated project emissions of particulate matter, nitrogen oxide, and sulfur dioxide, and a background visual range of 170 km, the following changes in contrast parameters were calculated:

plume/sky contrast change = -0.01
plume/terrain contrast change = 0.01
particulate matter-sulfate/sky-terrain contrast change = 0.00016

Because the magnitude of these contrast changes is less than the absolute value of ±0.1, the visibility impairment likely to occur as a result of phase III activities would not be significant, and no additional analysis for visibility impairment is required.

Acid deposition in the form of rain, snow, or dry deposition is also an air and water quality impact that could occur as a result of activities proposed by the applicants within the lease unit. The following is the annual estimated acid-sulfate deposition for phase III:

dry deposition	0.0024 kg/hectare/year
wet deposition	0.0024
total	0.0048

However, because the levels estimated for phase III are well below the assumed significance criterion of 5 kg/hectare/year, no adverse effects due to acid deposition are expected to occur (Oppenheimer 1982).

No adverse effects on other air quality related values are expected. (A detailed list and analysis of other air quality related values is given in the phase IV discussion.)

Phase IV. Phase IV air quality impacts were calculated for an operation with a production scenario as originally discussed by the applicants. As the level of sulfur dioxide impacts are highly dependent upon the location and configuration of the steam production boilers, the air quality modeling results must be considered as typical, and not as exact predictions of air pollution concentrations likely to result from tar sand extraction and upgrading. Any changes in location or other characteristics of the phase IV extraction and upgrading facilities would affect the impacts generated. Since the level of particulate matter impacts are also location and configuration dependent, particularly on the location, size, and configuration of the solid waste disposal area and the coke handling facilities, any significant changes in the character of these facilities could result in significantly different impacts from those estimated by the modeling. To correctly address the effects of such changes, a new modeling exercise would be required.

The mitigation of air quality impacts proposed by the applicants is the application of best available control technology (BACT) to all processes that emit

regulated air pollutants. The BACT level of mitigation would be required in any event by the state of Utah as part of the PSD permitting process. Specifically, the applicants propose the following controls on pollutant emissions. For sulfur dioxide emission control, the applicants would use fluidized bed combustion technology for the boilers, which would achieve 90 percent sulfur dioxide removed, and fuel gas desulfurization for the furnaces. Particulate matter emissions would be controlled by the use of cyclone and baghouse collectors on the boilers, baghouse collectors or water sprays with covered conveyor construction for all material-handling systems, and surface coatings or chemical sprays to control fugitive dust emissions from storage piles and other similar areas. Specially designed combustion systems for boilers and furnaces would be used to control nitrogen oxides emissions. Fugitive hydrocarbon emissions would be controlled by installing specially designed seals on pumps and other equipment. All concentration estimates assume the application of these controls.

Impacts on class II areas are summarized in table 36, which presents maximum short-term and annual average concentrations of sulfur dioxide, particulate matter, and nitrogen dioxide. All maximum calculated concentrations would occur within Glen Canyon National Recreation Area. Expected increases in sulfur dioxide were modeled based on extracted bitumen with sulfur contents of 2 percent, 4 percent, and 6 percent. This was done to provide an indication of the sensitivity of the estimated ambient sulfur dioxide concentrations to the as-yet unknown bitumen sulfur content. However, the results presented in this section address only the 4 percent sulfur scenario, which is consistent with the limited data available (UDNR 1979a).

Exceedances of the primary sulfur dioxide short-term NAAQS and the primary and secondary NAAQS for particulate matter would be expected. Therefore, because health effects NAAQS could be violated, additional as-yet undefined mitigation measures must be specified by the applicants before phase IV operations could proceed.

All class II PSD increments for sulfur dioxide and particulate matter would be exceeded. This analysis is not sufficient to judge whether the applicants could obtain permits. However, the degree of exceedance suggests that large emission reductions from those assumed in this analysis must be achieved before the applicants could demonstrate that the PSD increments would not be exceeded. Note that the class II PSD increments like the NAAQS are absolute in the sense that an applicant must demonstrate compliance. There is no provision for action by the federal land manager to allow exceedances based on adverse effects tests.

Impacts to neighboring class I areas could also occur as a result of phase IV activities (see table 37 for a summary of impacts on class I areas). No exceedances of NAAQS would be expected in nearby class I areas or in Capitol Reef National Park. However, the short-term class I sulfur dioxide increments would be exceeded in both Canyonlands and Arches national parks. In addition, the class I particulate matter increments would be exceeded in Canyonlands National Park.

Given the level of the exceedance of the 24-hour sulfur dioxide increment in Canyonlands National Park, the applicants would have to revise the plan of operations to achieve nearly an eightfold decrease in order to mitigate the

Table 36: Pollutant Concentrations Calculated for Phase IV Emissions

Pollutant	Averaging Time	Concentration (ug/m^3) Assumed Background*	Bitumen (% sulfur)	Project Contribution	Total	PSD Increment (Class II)	PSD Increment Exceedance Ratio	NAAQS	NAAQS Exceedance Ratio**
SO_2	3 hours	13	2	394	407	512	.77	1,300	.31
			4	787	800		1.54		.62
			6	1,181	1,194		2.31		.92
	24 hours	13	2	265	278	91	2.91	365	.76
			4	530	543		5.83		1.49
			6	795	808		8.74		2.21
	annual	13	2	13	26	20	.63	80	.33
			4	25	38		1.27		.48
			6	38	51		1.9		.14
Particulates	24 hours	90		306	396	37	8.28	260	1.52
	annual	19		141	160	19	7.42	75	2.13
NO_2	annual	13		79	92	--	.79	100	.92

Note: All calculated maximum concentrations are located in Glen Canyon National Recreation Area.

* See table 18.

** Exceedance Ratio = calculated concentration/PSD increment, except for NO_2 where ratio = NO_2 concentration/ NAAQS. Ratios greater than one indicate that the increment or standard may be exceeded.

Table 37: Pollutant Concentrations Calculated at Canyonlands, Arches, and Capitol Reef National Parks for Phase IV Emissions

Pollutant	Averaging Time	Concentration (ug/m^3) Assumed Background*	Bitumen (% sulfur)	Project Contribution	Total	NAAQS	PSD Increment (Class I)	PSD Increment Exceedance Ratio**
Canyonlands National Park								
SO_2	3 hours	13	2	98	111	1,300	25	3.93
			4	196	209			7.85
			6	294	307			11.8
	24 hours	13	2	13	26	365	5	2.56
			4	26	39			5.12
			6	38	51			7.68
	annual	13	2	0.6	14	80	2	.30
			4	1.2	14			.59
			6	1.8	15			.89
Particulates	24 hours	90		46	136	260	10	4.6
	annual	19		11	30	75	5	2.21
NO_2	annual	13		3	14	100	--	.14
Arches National Park								
SO_2	3 hours	13	2	17	30	1,300	25	.69
			4	35	48			1.40
			6	52	65			2.1
	24 hours	13	2	3	16	365	5	.58
			4	6	19			1.16
			6	9	22			1.74
	annual	13	2	0.05	13	80	2	.027
			4	0.1	13			.05
			6	0.2	13			.09
Particulates	24 hours	90		3	93	260	10	.3
	annual	19		0.05	19	76	10	.01
NO_2	annual	13		0.15	13	100	--	.15
Capitol Reef National Park								
SO_2	3 hours	13	2	12	25	1,300	25	.48
			4	24	37			.96
			6	36	49			1.45
	24 hours	13	2	1.6	15	365	5	.32
			4	3	16			.60
			6	4.7	18			.84
	annual	13	2	0.03	13	80	2	.016
			4	0.07	13			.033
			6	0.1	13			.05
Particulates	24 hours	90		1.5	92	260	10	.15
	annual	19		0.03	19	75	5	.007
NO_2	annual	13		0.1	13	100	--	.13

* See table 18.

** Exceedance Ratio = calculated concentration/PSD increment, except for NO_2 where ratio = NO_2 concentration/NAAQS. Ratios greater than one indicate that the increment or standard may be exceeded.

adverse effects. If this cannot be done, the applicants could ultimately have to petition the federal land manager for a certification of no adverse impact during the permitting process.

For phase IV, the ratio of reactive hydrocarbons to nitrogen oxide emissions is approximately 0.05. Therefore, because the ratio is much less than one, no substantial increase in ozone concentrations would be expected.

In addition to the above calculations, emissions of potentially hazardous and criteria and noncriteria pollutants were calculated for any such pollutants on which information was available. The calculated lead emissions rate is 0.026 pounds per hour, or 228 pounds per year. Because this is well below the EPA "de minimis" rate of 1,200 pounds per year, adverse impacts due to lead emissions are not expected. Calculated emission rates for vanadium and nickel are 0.47 and 0.23 pounds per hour, respectively. Because there are no published standards for acceptable ambient levels of these materials, the likelihood of adverse impacts cannot be assessed at this time. Aromatic hydrocarbons are a highly toxic class of hydrocarbons that have been linked with cancer and other health problems. These could be emitted in small amounts from the coking operation, but the amount of such emissions cannot be quantified at the present time. They are more likely to be of concern for worker health than as an ambient air problem for humans.

Using the estimated project emissions of particulates, nitrogen oxides, and sulfur dioxide and a background visual range of 170 km, the following changes in contrast parameters were calculated for phase IV activities:

plume/sky contrast change = -0.44
plume/terrain contrast change = 0.78
particulate matter-sulfate/sky-terrain contrast change = 0.01

As the magnitude of two of these contrast changes is greater than the absolute value of ±0.1, additional analysis for visibility impairment must be made to determine the significance of the visibility impairment likely to occur as a result of phase IV activities.

A level 2 screening analysis is the next step for assessing the potential for visibility impairment. Table 38 gives the plume observer geometry assumed for this analysis. Two time periods were chosen: 4 hours before solar noon, and 4 hours after solar noon. For the morning case, a very stable atmospheric condition (F-stability) with low wind speed (2 m/s) was assumed. The assumptions for the afternoon case were neutral conditions (D-stability) with a moderate wind speed (4 m/s). Assumed emission rates for 30,000-bpd production was used. These assumed conditions, coupled with an assumption that the plume is transported toward the observer, provide a conservative, but realistic, estimation of visibility degradation due to emissions released from the elevated stacks. As previously discussed, the specific indices of visibility degradation are the contrast of the plume against the sky (plume contrast) and the change in sky-terrain contrast caused by the plume (sky/terrain contrast reduction).

Table 38: Plume-Observer Geometry

Target	View Angle from North (degrees)	Target Distance (km)	Plume Transport Distance (km)	Angle Between Line of Sight and Plume Centerline (degrees)
Big Flat Top	288	50	26	77
Henry Mountains	241	90	12.5	19
Dark Canyon Plateau	206	48	21	40
Aquarius Plateau	257	166	20	34
Ekker Butte	220	9	19	20

Fugitive particulate emissions from ground-level sources were not included in the visibility analysis because plumes of this class of sources typically do not rise to heights much over 100 feet (Axetell and Cowherd 1981) and would, therefore, be below intervening terrain. Therefore, fugitive emissions should have little effect on visibility for the initial extraction zone. However, as the extraction zone moves and the boiler locations change, significant impact from fugitive emissions could be expected and must be included in any future visibility assessment based on site-specific information.

The calculation results (see table 39) for stable conditions show that the threshold for plume/sky contrast perceptibility would be exceeded for all targets for all wavelengths when the production rate is 30,000 bpd. Sky/terrain contrast reduction above the threshold would also be expected for the Henry Mountains, Dark Canyon Plateau, and Ekker Butte targets. The threshold for the Henry Mountains and Ekker Butte targets would also be exceeded for neutral conditions. Because stable conditions occur in this region 40 percent of the time in each season and the Salt Wash meteorological data indicate that winds with a southwesterly component can occur as much as 30 percent of the time, the probability of visibility degradation due to a perceptible plume is relatively high.

More refined analyses would be required to assess the potential for visibility impairment with a greater degree of accuracy and to assess the contributions of this source to uniform haze. These more refined analyses must include a detailed review of the frequency of occurrence, magnitude, duration, and geographic extent of any visibility impairment. Such a detailed analysis is not possible at this time because of the uncertainties in pollutant emission rate and source configuration. For example, the preliminary analysis indicates that the upgrading facility would be the principal source of a perceptible plume due to its relatively high nitrogen oxides emissions, so the exact location and characteristics of the upgrading facility are crucial to the analysis. However, it is beyond the scope of this analysis to arbitrarily change the basic source configuration or extraction methodology proposed by the applicants.

Table 39: Level-2 Visibility Analysis for Phase IV (30,000 bpd)

Target	Wavelength	Plume Contrast	Contrast Reduction
Big Flat Top	.40	-0.386	0.023
	.55	-0.223	0.047
	.70	-0.149	0.067
Henry Mountains	.40	-0.479	0.006
	.55	-0.435	0.065
	.70	-0.348	0.134
Dark Canyon Plateau	.40	-0.360	0.041
	.55	-0.199	0.106
	.70	-0.122	0.147
Aquarius Plateau	.40	-0.447	0.000
	.55	-0.339	0.006
	.70	-0.234	0.024
Ekker Butte	.40	-0.359	0.476
	.55	-0.312	0.429
	.70	-0.227	0.423

In addition to calculating ambient pollutant concentrations and visibility impacts, the effects of predicted pollutant concentrations on sensitive plant species were analyzed.

Significant biological effects have been reported for the following species (grasses and annuals) known to occur in Glen Canyon National Recreation Area or Canyonlands National Park (Loope 1977) at the indicated sulfur dioxide exposures:

	Concentration	Averaging Time
Agropyron smithii	52 ug/m^3	annual
Oryzopsis hymenoides	338 ug/m^3	6 weeks

(The second grass is a dominant species in grasslands in both park units.)

Erodium cicutarium	572 ug/m^3	16 weeks
Helianthus annuus	130 ug/m^3 and 260 ug/m^3	5 weeks

(Other annuals are probably equally sensitive.)

In order to assess the potential impact for those species where the exposure times for the known effects thresholds were five or six weeks, an additional LONGZ model run was made to determine monthly average concentrations. The monthly concentration estimates ranged from 15 to 78 ug/m^3 with a monthly mean

of 32 ug/m³. Therefore, concentrations in excess of the known effects thresholds for Oryzopsis hymenoides, Erodium cicutarium , and Helianthus annuus are not expected to occur. Similarly, the annual concentration estimate was 26 ug/m³ which is below the effects threshold for Agropyron smithii.

Lichens are a dominant plant type in both parks due to the extensive occurrence of cryptogamic crusts. Of the few species that have been noted for Canyonlands National Park, none have been studied for sulfur dioxide sensitivity. A number of lichens and mosses are known to disappear from habitats where the annual average sulfur dioxide concentration exceeds 40 ug/m³. However, the estimated annual concentration is 26 ug/m³, which is below the effects level. Therefore, based on the information available at this time, the estimated sulfur dioxide concentrations are not expected to exceed effects thresholds for sensitive species.

In addition, some visible injury studies have indicated that Pinus edulis (a dominant tree in Glen Canyon and Canyonlands) has an intermediate sensitivity to sulfur dioxide. However, studies of other species of Pinus have shown the genus to be extremely sensitive to low levels of sulfur dioxide. Growth reductions, and more importantly, decreased seed germination and emergence appear to be common for the other species. Therefore, Pinus edulis should be included in the list of air quality related values, but additional research is needed to document effects levels.

Commercial development activities would generate quantities of pollutants that could result in acid deposition. The following is the annual estimated acid-sulfate deposition for phase IV:

dry deposition	0.0032 kg/hectare/year
wet deposition	0.0032
total	0.0064

However, the total acid deposition rate anticipated is well below 5 kg/hectare/year, so adverse effects due to acid deposition are not expected (Oppenheimer 1982).

Secondary air quality impacts are those caused by emissions from activities supporting the project, such as particulate emissions due to increased population and increased vehicular use in the general area. The centers of population (Green River in Emery County and Hanksville in Wayne County) that would be the sources of such emissions are distant from the project area and are expected to make only minor contributions to the ambient concentration estimates due to the project; model calculations using these emissions were not made. Total emissions in Emery County would increase by about 12 percent. This is not considered to be a significant increase, and no measurable changes in ambient air quality are expected to occur. Total emission increases in Wayne County of 94 percent above present emission levels are predicted. Although this is a large percentage increase, the county is currently experiencing such low emission levels that any increase appears as a large increase over baseline. However, the actual amount of emissions would still be low, and even with the increase, total emissions for Wayne County would still be less than one-third that experienced by Emery County. Based on vehicular and other emissions predicted to occur as a result of population increases, both Wayne and Emery counties would retain their essentially rural, clean air characteristics.

Air pollution effects on the rock art in Horseshoe Canyon and in the Maze have not been studied in detail. The predicted annual average concentrations for sulfur dioxide would be less than 0.5 ug/m^3. Since annual averages for sulfur dioxide in regions where significant damage to buildings and archeological resources have been documented typically run 1,000 ug/m^3 or higher, no such damage can be predicted for the rock art in the near timeframe of 30 to 50 years. The same is true for damage due to acid deposition, where predicted annual averages would be below 0.005 kg/hectare/year at Horseshoe Canyon, and 0.02 kg/hectare/year at the Maze, which are below any measurable effects level on an annual basis. Soiling due to particular matter also would be unlikely on an annual basis, predicted particulate matter concentrations would be about 5 ug/m^3 for the Maze and 2 ug/m^3 for Horseshoe Canyon (annual average). However, this project could have a life of up to 160 years. Over such a long period of time, even very small incremental increases in exposure to sulfur dioxide, particulate matter, and acid deposition could result in increased rates of deterioration of the rock art.

Noise

Noise impacts generated during phase I and II operations would be transitory and of short duration at each proposed corehole. Because the proposed sites are widely scattered throughout the lease unit, noise interaction between the individual sites is not expected to occur. Noise would be generated from vehicular traffic and from clearing, leveling, and drilling at each of the 15 coreholes during phase II. The short-term maximum level of 36 dbA at 1,000 feet from the drilling site is equivalent to maximum background daytime noise levels typical for rural areas (see appendix G for a discussion of the calculation methodology used throughout this section). Due to the short duration and relatively low noise levels, no auditory or nonauditory effects on area visitors or residents are expected during phases I and II.

Noise levels generated during phase III, however, would be higher than for phases I and II and would endure for a longer period of time. Two types of noise generation would occur during phase III--noise related to construction, and noise related to operating the pilot-scale facilities.

Although construction noise would not be continuous over a 24-hour period, the maximum noise level generated at the construction stage of 42 dbA at 1,000 feet is likely to be noticeable. However, this noise level is still relatively low, and no adverse auditory effects on area visitors or residents are expected.

Operating the pilot facility would create continuous noise over a 24-hour period, which is considered to be more disruptive for humans than daytime-only noise (EPA 1974). Individual operational noise sources (injection wells, production wells, and other pilot-phase facilities) would be located sufficiently close to each other to interact, so a preliminary calculation must be done to produce an equivalent noise level for the entire pilot plant area. Workers who come into close contact with noise sources would be required to wear hearing protection.

The maximum operational noise level of 43 dbA at 1,000 feet is substantially higher than the maximum noise level of 35 dbA typical for rural areas. Nonauditory effects (annoyance, irritation, and aesthetic objections to increased noise levels within WSAs, Glen Canyon National Recreation Area, and the Maze district of Canyonlands National Park) are more likely to occur at the operational stage of phase III. The facilities would be located near the Flint Trail, a major visitor access route, and not far from overlook, hiking, camping, and residential areas.

Wildlife in the immediate vicinity of the phase III operations would leave the area, so no auditory effects on wildlife are expected. However, nonauditory effects such as disruption of feeding, breeding, and migration paths are likely to occur within wildlife populations near the pilot plant operations.

Noise generated by phase IV construction activities would recur at intervals during the life of the project as portions of the wellfield are exhausted and new wellfields are drilled. Construction noise usually would not be continuous over a 24-hour period (see table 40 for a listing of maximum decibel levels generated during the construction stage). Total noise generated by construction activities would depend upon how many wells are being drilled at once, the type of equipment used, and whether construction activities are carried on simultaneously with the operations. The typical noise levels (54 dbA) calculated for a receptor 1,000 feet from the construction activity approaches the limit of 55 dbA maximum recommended by the EPA as acceptable for areas where outdoor activities take place. Noise generation at the construction stage was calculated to be of sufficient duration and intensity to cause auditory effects on sensitive receptors within 600 feet of the project site, if they remain at that point without hearing protection for 8 hours (EPA 1974).

Table 40: Noise Levels for Phase IV

Receptor Distance From Site	Construction (daytime only) L_{eq} = 104 dbA	Operation (day and night) L_{eq} = 115 dbA
250 feet	67 dbA	78 dbA
500 feet	61	72
1,000 feet	54	66
1 mile	40	51
2 miles	34	45
5 miles	26	37
10 miles	--	31

The duration of noise from phase IV activities could be up to 160 years. Noise levels sufficiently high and of sufficient duration to cause adverse auditory effects on area visitors, residents, and workers could occur, but visitors could avoid temporary or permanent hearing loss by not lingering near the operational facilities for any length of time. Workers would be required to wear hearing protection. Relative sensitivities of receptors (human or wildlife) have not been identified. Levels significantly above background could occur for a distance of up to 5 miles from the wellfields and upgrading facilities at the operational stage (see table 40).

Noise levels in Green River and Hanksville would likely increase because of project-related heavy truck traffic. During phase IV operations, up to 150 additional heavy trucks per day would pass through or into these communities. Peak noise levels from haul trucks traveling at 35 miles per hour (mph) or greater would be 86 dbA, measured at a distance of 50 feet from the noise source (EPA 1971). Green River is currently experiencing relatively high traffic noise levels due to heavy truck traffic; increases in the frequency and magnitude of such noise effects could occur but cannot be accurately quantified at this time. Resultant impacts on the population could include interference with speech and a temporary inability to hear speech, as well as disruptions of sleep and concentration. Noise effects would range from minor annoyance to disruption of normal activities but would not cause serious health problems (USDOT 1978).

Scenic Quality

The scenic quality of the proposed federal lease unit would not suffer major impairment during phase I operations. The proposed coreholes would not be visible from overlook areas along the Big Ridge but would be noticed by visitors traveling along the Flint Trail.

Some of the phase II coreholes would be visible from overlook areas along the Orange Cliffs and the Big Ridge, and visitors would be able to see the drill rigs when they are in place. The sites would be less noticeable after drilling operations are completed, and after the individual coreholes are plugged and abandoned and the pads reclaimed. None of the drill sites would be visible from Canyonlands National Park even during active drilling operations.

The phase III activities located in the open park-like environment of Gordon Flats would be visible from highly sensitive NRA lands, including several overlooks along Orange Cliffs and Big Ridge. In addition, most phase III activities would take place within one-half mile of the Flint Trail, the access road used by visitors to both the recreation area and the Maze district of Canyonlands National Park. Activity would also be visible from portions of the French Spring/Happy Canyon WSA, although the overall impact on visitors to the WSA would be minimal due to the relatively short duration of phase III activities.

The visual character of the phase IV wellfield and associated pipeline system and steam generation and upgrading facilities would provide a maximum contrast to the surrounding natural environment, resulting in significant alteration of the scenery in the vicinity of the activities. Relocating the facilities to allow screening by pinyon-juniper vegetation would only minimally reduce the impacts because stand density and height are insufficient to totally screen the facilities. Vegetation removal necessary for wellfield construction would also minimize the effectiveness of vegetation screening as a technique for reducing scenic impacts.

Landscape alterations occurring during phase IV operations were analyzed separately for BLM lands and NPS lands. On BLM lands, impacts were considered significant for visual resources if modifications in the landform and vegetation or the addition of a structure would not meet the standards of the BLM

visual resource management (VRM) class for the area where activities would occur. On NPS lands, impacts were considered significant if the modifications would diminish scenic values that have been identified as values for which the area was set aside as a unit of the national park system.

On BLM lands, phase IV activities would significantly alter the natural, undisturbed landscape of over 19,000 acres. Intrusive modifications within the proposed unit include roads, wellfields, buildings, pipelines, heavy traffic, dust, and smoke. Because of the life of the proposed project and length of time necessary to minimize the visual contrast through reclamation, all impacts are considered long term. The overall impacts of the project were considered to be subjectively more severe in this area, because the existing landscape is essentially devoid of development. The visual sensitivity of the lands is enhanced because of their proximity to a national recreation area and scenic overlooks enjoyed by visitors to the region.

Constructing components of the proposed tar sand development would exceed the allowable BLM management standards in all three VRM classes (II, III, and IV) found within the proposed federal lease unit; 5,589 acres of VRM class II would be the most severely affected. In addition, 3,040 acres of VRM class III and 10,454 acres of VRM class IV lands would also be affected. The upgrading plant site located on the mesa top (VRM class IV) above Happy Canyon would present a maximum contrast to the existing landscape character. Because this plant would be silhouetted on the horizon, it would also be visible from approximately 8,780 acres within the French Spring/Happy Canyon WSA (45 percent of the total WSA acreage).

Disposing solid waste (boiler waste and silt) was assessed as imposing a new and contrasting landform on the natural scene. Although the plan of operations does not specify where this material would be disposed of, the DEIS assumes it would be somewhere within the unit. Whether disposal takes place at the head of small side canyons or on mesa tops, it would create a contrasting landform in both texture and color. Reestablishing natural vegetation on these tailings would be difficult, if not impossible, and the visual contrast could endure for hundreds of years.

Phase IV activities would also diminish the scenic values of NRA lands within the lease unit for the duration of the project and seriously impair these same values for years following abandonment because of the amount of time necessary to restore vegetation to its preproject character. The value of Orange Cliffs as a scenic buffer to Canyonlands would also be seriously diminished. Some aspects of the operation would be visible from within Canyonlands, especially at night when reflected lighting and noise would intrude on the wilderness characteristics of the Maze district within the park.

Activities for the projected life span of the project would occur adjacent to and within immediate foreground views of the primary access road into the national recration area, as well as the Maze district of Canyonlands. Every major overlook point within the national recreation area along Orange Cliffs (except possibly Panorama Point) would allow views of the project, and in many cases would be surrounded by project activities and equipment. The upgrading plant would be visible from 17,566 acres within the lease unit and from all six overlooks located along Flint Trail. The facility would not, however, be visible from either Panorama Point in Glen Canyon National Recreation Area or

Island In The Sky overlooks in Canyonlands National Park if the stack heights are kept below 325 feet. Any visible smoke plume from the plant, however, would be visible to visitors at those points. All the proposed relocations of the fluidized bed combustion units for steam generation would be visible from two to five major overlooks depending upon exact location. The Twin Corral site would be the worst location, from a scenic resource standpoint, because it would be visible from five overlooks. Site #3, located in Happy Canyon, would be the least intrusive. The proximity of the tar sand activities to the overlooks would diminish the quality of the views from these overlooks, which allow views into some of the most remote wilderness areas of Canyonlands National Park (see figure 35). Bagpipe Butte overlook would be affected most directly by operations in prospective areas #1 and #7; Flint Trail overlook by operations in area #10; Gordon Flat overlook by operations in areas #5 and #6; Sunset and Teapot Rock overlooks by operations in areas #11, #21, and #22.

When full phase IV development is underway, there would virtually be no location along the Flint Trail within the national recreation area where some aspect of tar sand development would not be visible. Even if a parallel road is constructed in an attempt to separate park visitors from commercial activity the narrow necks along the ridge would force an overlap of these two conflicting uses. Many of these narrow necks also coincide with the critical overlook points, making separation of the overlooks and the development activities impossible. The long-term contrasts created by adding large, intrusive man-made structures, superimposing unnatural landforms such as waste disposal piles, and a rigid grid system of well patterns on an undisturbed landscape would be one of the predominant adverse impacts of this proposal. The visual pattern of shrub and woodland would be dramatically modified by the straight lines created by constructing roads and well patterns. Even if reclamation efforts are successful, color and size contrasts between the old vegetation and new would emphasize the contrast for many years.

If water is taken from the Dirty Devil River, a 12- to 15-mile-long buried water pipeline would be required to bring the water to the project location. This route would be across VRM class II lands, and, as proposed by the applicants, approximately 6½ miles of the pipeline would pass through the Dirty Devil WSA; however, such an alignment may not be possible while the nonimpairment management standard is in effect. Visual contrasts created by the facilities at the diversion point on the Dirty Devil are expected to exceed the allowable level of contrast for VRM class II lands. In addition, vegetation removal and grading for pipeline construction would result in exceeding the allowable level of contrast for class II lands. Portions of the water pipeline within the Dirty Devil WSA could be routed around the WSA at additional cost to the applicants, but adverse impacts on the visual resources of lands along the pipeline route and at the diversion point on the Dirty Devil River would remain.

IMPACTS ON CULTURAL RESOURCES

Historic Resources

Phases I, II, and III would have no effect on the Wolverton cabin, the single known historic resource in the Flint Flat area; however, the phase III

construction and operation activities in the Flint Flat/Flint Seep area would certainly destroy the context and setting of the Wolverton cabin, and possibly damage or destroy the cabin itself.

Because little or no survey work has been done to determine whether there are other historic resources within the lease unit (or whether such resources would be eligible for inclusion on the National Register of Historic Places), direct effects on such resources cannot be identified at this time. Complete surveys prior to commencing any ground-disturbing activities would be required, including identifying appropriate mitigative measures (such as avoidance, documentation, and salvage).

Indirect impacts on known and unknown historic resources due to increased visitation, changes in the character of the visitation, and use by the applicants' workers and their families are likely to occur, ranging from general wear and tear to increased vandalism. Such impacts could be mitigated by management control by the applicants (to minimize vandalism by employees) and by increased NPS and BLM resource protection efforts.

Archeological Resources

The coreholes proposed for phases I and II are immediately south of the Gordon Flats district within the proposed Orange Cliffs Multi-Resource National Register property (see figure 10). This district contains a cluster of the more significant archeological sites within the larger Orange Cliffs locale (see figure 36) and includes the most extensive hearth areas recorded in the lease unit to date.

Limited archeological surveys in the area of phase I activities have yielded three archeological sites (42WN1280, 42WN1379, 42WN1380). Two sites (42WN1379, 42WN1380) would be destroyed if drilling and associated activities are located as proposed by the applicants, but, as minor siting adjustments likely can be made to avoid the archeological sites, major adverse impacts are not anticipated. Because upgrading the Flint Trail between UT 24 and Gordon Flats is not proposed for phases I and II, the 38 known archeological sites along that route would not be directly affected.

Phase II activities would have a greater impact on archeological resources; two coreholes are scheduled for the proposed French Spring district, and four are on the edge of the proposed Flint Seep/South Fork Happy Canyon district within the proposed Orange Cliffs Multi-Resource property. The nine remaining phase II coreholes are in areas that have not been surveyed for archeological materials, and their specific direct impacts cannot be evaluated. From the density of site data in other portions of the lease unit, it can be assumed that sites do occur in the vicinity of these nine coreholes.

The phase III double five-spot well pattern proposed for the Gordon Flats area, the associated facilities, and access would, depending upon the exact location and configuration of the facilities, disturb a portion of the proposed Gordon Flats district. At least 38 archeological sites could be disturbed if the Flint Trail is upgraded from UT 24 to Gordon Flats. These sites would require

testing, mapping, collecting, or excavation, as appropriate. Because the acreage disturbed during phase III is concentrated in one specific geographic location, moving facilities to avoid damage to sites may not be feasible. At or before phase III activities are initiated, an areawide mitigation plan would be developed in consultation with the Utah State Historic Preservation Officer and the Advisory Council on Historic Preservation. It would specify mitigation and compliance requirements and guide the necessary archeological work.

Full production under phase IV would have a major detrimental effect on the area's archeological remains. The type and intensity of development proposed, including active disturbance of 1,400 acres at any one time and up to 54,253 acres ultimately, is incompatible with the requirements of site protection, preservation, and interpretation. The archeological site density in the proposed federal lease unit is very high, and the sites are extensive and significant. At least 178 known archeological sites could be affected, and though comprehensive, detailed surveys have not been done, it is hypothesized from existing site density data that a minimum of 2,000 archeological sites could be affected over the life of the project.

Prior to initiating ground-disturbing activity, a 100 percent thorough and systematic archeological survey would be required. All sites located during the comprehensive archeological survey would be evaluated for their contribution to the proposed Orange Cliffs Multi-Resource National Register property in accordance with Executive Order 11593 and with the National Historic Preservation Act of 1966, as amended. Mitigation would be carried out in accordance with the approved archeological resources mitigation plan (described in the phase III discussion above). Complete mitigation of the intrusion on and loss of data for the Orange Cliffs Multi-Resource property would not be possible. The larger number of archeological sites that would be destroyed would result in a loss of information and decrease of integrity for the National Register property.

Indirect impacts on archeological resources would extend well beyond the borders of the proposed federal lease unit due to the increased numbers of people who would be within archeologically sensitive areas. It is expected that, in addition to the increased numbers of people in the area who are employees of the companies involved in tar sand development and related activities, there would be increased numbers of recreation visitors if the existing Flint Trail to and within the national recreation area is upgraded. Of special concern are sites in Canyonlands National Park nearby that are listed on the National Register of Historic Places (these areas within Canyonlands National Park are accessible via the Flint Trail and other roads and trails that pass through or are accessed near the proposed project area). The spectacular and highly significant rock art in the Horseshoe Canyon detached unit of Canyonlands National Park to the north of the proposed project area is expected to receive heavier visitation, with a concomitant increase in vandalism and other destructive effects. Disturbance of the numerous sites that contribute to the complex of sites in the proposed Orange Cliffs Multi-Resource National Register property would also occur as a result of increased visitation and other activities.

Indirect impacts (such as those due to vandalism, illegal artifact collecting, and increased offsite land and unauthorized offroad vehicle use) could be partially mitigated by resource protection efforts restricting offsite and

unauthorized offroad use and implementing an educational program designed to develop an appreciation for the heritage value of the sites and a sensitivity to their preservation. However, no mitigation program can ensure that no data would be lost.

The indirect impacts of full development on the area's rock art as a result of air emissions from the upgrading facility cannot be adequately addressed at this time, as insufficient data exist, but the deleterious effects of such emissions on monumental architecture and buildings have been well documented in other parts of the world. Such effects include deterioration of stone, alteration of pigments, and staining or darkening.

IMPACTS ON SOCIOECONOMIC ENVIRONMENT

Phases I, II, and III

No effects are expected on the grazing administration of the Robbers' Roost allotment or on grazing and livestock production within the proposed federal lease unit from phase I and II activities. During phase I, a maximum of 7 acres of vegetation would be removed within the Robbers' Roost and Sewing Machine grazing allotments, which would slightly reduce the estimated carrying capacity of the area for grazing. The maximum loss of carrying capacity within the Robbers' Roost grazing allotment is estimated at 2 to 3 animal unit months (AUMs). Only 2 acres of vegetation would be removed within the Sewing Machine allotment, and no noticeable effects on grazing within this allotment are expected.

Phase I and II activities would have no discernible effect on population or employment within the region. A maximum of 10 persons would be employed for a 2-week period during phase I and for a 15-week period during phase II.

Phase I core drilling would take place within Glen Canyon, and phase II drilling would take place both within Glen Canyon and on adjacent BLM lands. No effect is anticipated on BLM management or resource protection, and minimal effect is anticipated during phase II. Some additional resource and visitor safety protection efforts would be required of NPS personnel during phases III and IV at the Hans Flat ranger station (warnings about truck traffic and notifying visitors that drilling activities are taking place in the Gordon Flats area). No increase in operations personnel or facilities would be required for either the BLM or the NPS. For phase II, an estimated 220 workdays of additional NPS staff time would be required at the ranger station for visitor protection and monitoring activities; for phase III, an estimated 504 workdays of additional staff time would be required. Initial response for law enforcement, fire protection, and public safety in and around the pilot plant would be the responsibility of the NPS, with assistance from county public safety services. Compliance monitoring would also be carried out by personnel from both agencies with the NPS having the larger responsibility.

Constructing the phase III pilot facilities would provide temporary employment for approximately 25-30 persons (18 months to 2 years). No permanent facilities would be built onsite, and workers would be housed in nearby communities

(Green River or Hanksville). No data are available on whether workers would be chosen from the local labor force or brought in from other parts of the country; it is likely that there would be both local and out-of-area hiring, depending upon the skills needed. Due to the small number of workers anticipated and the relatively short duration of phase III activities, overloading of surrounding communities or community facilities are not expected.

Phase IV impacts on the socioeconomic environment are extensive, affecting all economic sectors. The following discussion summarizes the major changes that can be expected, as excerpted from the Argonne National Laboratory report (Argonne 1983).

Phase IV

Population and Employment. Under initial phase IV construction and operation within the 18 prospective areas, the construction workforce would peak in 1994, and the operational workforce would peak one year later, in 1995. As each prospective area is exhausted, peak construction workforce would recur; such recurrences cannot, however, be predicted accurately at this time. The initial peak commercial development would increase the population of Wayne and Emery counties by 4,279 in 1995. The community of Green River would experience a population increase of 1,588 people (136 percent increase over baseline projections) and Hanksville a population increase of 2,432 people (507 percent increase over baseline projections). This level of growth would have a major effect on these two small rural communities. Such a major increase in population would outpace available infrastructure and services for a time, but could have beneficial effects if the growth results in infrastructure improvements and increases in available services.

Total employment for the two-county area in 1995 would increase by 1,734 people (153 percent) over the baseline projected for Wayne County and by 282 people (4 percent) for Emery County. For Wayne County, the largest gains by sector would be in mining (878 percent increase) and construction (640 percent increase) for the peak workforce year. The 4 percent increase projected for Emery County could be absorbed by the present unemployed workforce. Although such dramatic increases in the number of employment opportunities available appear to be beneficial to local residents, energy projects, especially ones using a developing technology, are highly specialized and usually require skills not found in the local labor force. This high growth in employment, however, is expected to decline by the year 2005, so that employment due to the project would be about one-third the level reached in 1995. This decrease amounts to a yearly decline of 11.01 percent between 1995 and 2005. However, successive development of the prospective areas over a period of up to 160 years would promote "boom and bust" cycles, with corresponding employment and unemployment cycles, at 5- to 10-year intervals.

Personal Income. Phase IV development would increase the personal per capita income (PCPI) by 58 percent in the two-county area during the 1995 peak workforce year. The project would raise the PCPI to an estimated average of $16,428 (in 1980 dollars) in the two counties by 1995, as compared to a projected baseline average PCPI of $9,568 without the project. Such increases would be beneficial to the individuals who receive them.

Most of the increase would occur in Wayne County and affect the cost of consumer goods and services and the cost of housing. Local price inflation would likely occur due to the local increases in purchasing power. This localized inflation effect could have a serious impact on long-time residents, especially those living on fixed incomes, but would probably not seriously affect those enjoying increased incomes due to project-associated employment.

Housing. New households (growth above baseline) projected under phase IV development are expected to reach a peak of 1,376 in 1995. The communities of Hanksville and Green River would be unable to meet this increased housing demand from existing housing stock. Even with existing vacancy rates of 10 to 20 percent, neither community has sufficient housing to accommodate the expected growth. Of the two counties, Wayne County would experience the highest increase in housing demand (78.5 percent). As available housing stock is not sufficient to meet the projected demand, shortfalls in the amount of adequate housing and significant rises in the prices of existing housing could result.

Education. Significant increases in the demand for teachers and classroom space would occur as a result of phase IV development. Wayne County would be the most severely affected, with an estimated demand for 24 additional teachers and classrooms in the peak workforce year of 1995, to handle the expected increase in students of 576 over the projected baseline number. Emery County would have a demand of 18 additional teachers, an increase of 21 percent to handle 437 additional students. These increases would increase the pupil-to-teacher ratio, at least in the short run, and could thus adversely affect the quality of education received by the children of local residents.

Law Enforcement. Additional jail facilities would be required in both Emery and Wayne counties. By 1995 there would be a projected need for nine additional law enforcement officers and patrol vehicles for the two counties. The increased demand for law enforcement support on NPS lands is expected to grow by 10 times during phase IV activities. Providing additional services would result in a fiscal and administrative burden for surrounding communities and the NPS.

Fire Protection. Additional fire protection equipment would be required for communities in the area, particularly Hanksville. Within the processing plant perimeters, new fire protection facilities and equipment would be provided by the applicants. Additional firefighting facilities would also be required for the Hans Flat ranger station and would probably have to be provided by the NPS. The additional industrial activity and the extraction and upgrading facilities would likely result in an increase in wildland fires, and fires involving flammable liquids and other hazardous materials could occur. The latter type of fire would require a more highly trained fire suppression force than is currently available in the area.

Health Care Services. All medical services and facilities would be severely affected by full phase IV development. None of the surrounding communities reasonably accessible from the proposed federal lease unit have facilities sufficient to support the increase demand for health care services that would be generated by the project. Seven additional emergency medical technicians would be required to handle expected demand in each county.

Public Utilities. As the existing water, sewer, and power generation facilities are currently operated at or near capacity, the increased staffing required for phase IV activities would necessitate constructing additional utility services approximately twice the capacity of the existing facilities. None of the surrounding communities have public utilities that could be extended into the project area. Hanksville currently has no public sewer, water, or solid waste facilities, and Green River currently has no excess capacity. Sewer, water, solid waste disposal, and power generation facilities would be required both within the proposed federal lease unit and within surrounding communities (particularly Hanksville and Green River). Providing such facilities would be a fiscal and administrative burden for affected communities.

Attitudes and Lifestyles. The local populations of Green River and Hanksville could perceive the tar sand development as an enhancement of their lifestyles due to the increase in employment opportunities and community amenities associated with population increases and higher income levels. These communities would experience a diminution of traditional smalltown cultural values due to the increase in population and the consequent decrease in cultural homogeneity but would experience an increase in cultural diversity. In Hanksville, the likelihood of major social changes would be the greatest, as newcomers would outnumber longtime residents by the year 1992. The social consequences arising from western energy related "boom town" developments have been well documented and are generally conceded to adversely affect longtime residents, as well as the newcomers (Cortese and Jones 1977).

Transportation and Access. Depending upon the main access route chosen by the applicants for a given point in the development of the lease unit, either the dirt access road into the project area from UT 24 at Temple Junction or the unimproved road from UT 95 into the proposed lease unit via Poison Spring and Hatch canyons could be upgraded. The first option would require eventual upgrading a minimum of 45 miles of existing unpaved road from the UT 24 to the initial development site at Gordon Flats. The Poison Spring Canyon route would require upgrading a minimum of 48 miles of unpaved road to reach the same point (at Gordon Flats) within the lease unit. This option would probably require constructing a bridge across the Dirty Devil River. Heavy use of these roads by the applicants during phase IV would contribute to the overall degradation of the remote and primitive backcountry experience currently sought by most visitors to the area (see the "Recreation and Wilderness" sections).

Workforce commuters from Hanksville and Green River and heavy truck traffic would compete with the existing traffic volume on UT 24 and I-70 into Green River. During phase IV, heavy truck traffic along UT 24 from Temple Junction to I-70 would exceed the level of service for that road segment. The level of service refers to the maximum number of vehicles that can pass over a given section of roadway during a specified time period; it is a qualitative measure of the effect of several factors, including speed and travel time, traffic interruptions, freedom to maneuver, safety, driving comfort and convenience, and operating costs. Significant increases in high tonnage truck traffic would result in damage to road surfaces and an increase in the number of accidents, particularly at intersections. Table 41 contains the maximum increases in vehicle use (over 1981 baseline levels) that would occur as a result of phase IV activities.

Table 41: Projected Average Annual Daily Traffic
(Maximum Year Projections -- 1995)

Highway Link	Commuter	Truck	Number of Vehicles (without project) 1981	(with project) 1995
UT 24 Hanksville to Temple Junction	700	--	483	1,183
UT 24 Temple Junction to I-70	528	150	483	1,161
I-70 UT 24 junction to Green River	528	150	2,938	3,616

A product pipeline could be required to transport syncrude offsite. Two possible routes have been suggested by the applicants. The northern route would involve a pipeline crossing the Green and Colorado rivers north of Canyonlands and Glen Canyon. The southern route would include a pipeline crossing the Colorado River within Glen Canyon. No specific design or alignment has been identified. The construction of a product pipeline could have impacts on Glen Canyon if an alignment is through the recreation area. The impacts would be analyzed if and when the applicants submit a specific pipeline proposal.

Green River could serve as a railhead (Denver, Rio Grande, and Western railroad) for transporting the hydrocarbon product to existing refinery facilities, the closest of which is in Grand Junction, Colorado. This refinery is designed to process specific types of hydrocarbon crudes and is not now able to process syncrude of the type generated from tar sand bitumen extraction.

Grazing and Livestock Production. Phase IV activities would reduce the total acreage available for cattle grazing by an estimated 1,400 acres at any given point in time. Additional acreage would be in the process of revegetation and reclamation as the development moves throughout the proposed federal lease unit. Since reclamation success may depend upon exclusion of cattle until the newly established vegetation is sufficiently healthy to support grazing, additional acreage would also be effectively removed from grazing for a minimum of five years, until vegetation suitable for grazing could be reestablished. Most of the impact would be felt within the Robbers' Roost allotment. There would be an estimated loss of carrying capacity on Big Ridge of 25 to 50 AUMs, or four cows per year, depending upon the exact location and configuration of the phase IV facilities.

The effects on overall carrying capacity of the three BLM grazing allotments are not expected to be significant. Less than 9 percent each of the Robbers' Roost and Sewing Machine allotments are actually within the proposed federal

lease unit (see figure 41). Although 33 percent of the Flint Trail allotment is within the proposed unit, it is currently unallotted. As long as the nonimpairment standard is in effect for WSAs, 65 percent of the grazing use on BLM land would remain largely unaffected by operations. For areas where past operation reclamation is successful, grazing capacity could be increased due to a shift in vegetation type to higher forage productivity species.

If water sources are eliminated or if cattle are excluded from water sources by operational activity, the practical effect would be to limit the carrying capacity of the portions of the allotments within the proposed area of vegetation disturbance. For example, the dirt stock tank in the Gordon Flats area would likely no longer be usable once phase IV construction and operations commence. The loss of this particular cattle watering source would have no long-term effect on grazing resources as long as a suitable substitute water source could be developed in the same general vicinity.

As the Flint Trail would be used for project access and the road is currently unfenced, increased road traffic due to phase IV construction and operation activities could result in vehicle-cattle collisions. Fencing the road right-of-way to exclude cattle and installing cattle guards would reduce the occurrence of such collisions.

IMPACTS ON LAND USE

Phases I and II would in general be in conformance with local, state, and federal land use planning criteria for the area.

Phase III and phase IV would cause major impacts to recreational, scenic, scientific, and cultural values. However, such developments would be in conformance with local state planning criteria. This alternative would likewise be in conformance with the BLM existing land use plan classification as category 1 (suitable for leasing with standard stipulations only) except where BLM may choose to impose additional protective restrictions.

Applying the BLM wilderness nonimpairment standard for the French Spring/Happy Canyon, Horseshoe Canyon, and Fiddler Butte WSAs could prevent authorization of any such activities determined by the BLM not to be in conformance with the nonimpairment management standard. Exploration phases I and II could be conducted if the BLM determines that nonimpairment criteria would be satisfied.

The scale, scope, and duration of phases III and IV would conflict with the preservation of scenic, scientific, and cultural values contributing to the public enjoyment of NPS-administered lands; therefore, these activities would not be in conformance with the land use plans and management constraints for both the Orange Cliffs, Glen Canyon National Recreation Area, and the Maze district of Canyonlands National Park.

IMPACTS ON RECREATION AND WILDERNESS VALUES

Phase I and II activities would conflict with primitive and unconfined recreational values because of the drilling equipment traffic along the dirt access

road from Temple Junction at UT 24 to the Hans Flat ranger station. This 50-mile dirt road through BLM-administered lands furnishes visitor access to the Orange Cliffs area within Glen Canyon National Recreation Area and to the Maze and Horseshoe Canyon areas within Canyonlands National Park. The road access provides visitors with an experience of spatial isolation and remoteness, complementing the NPS management objectives for the area. The drilling would detract from the goal of providing primitive and unconfined recreational experiences for approximately 1,200 yearly visitors to the area, but this conflict is of short duration (a maximum of two weeks). As the duration of phase activities is short and the geographic area involved is small, the effect on overall long-term recreation management is minimal.

Phase III activities would continue a trend of primitive and unconfined recreational experience degradation initiated with phases I and II. Additionally, the phase III facilities would cause visual and noise intrusions and increased vehicular traffic. The duration of the phase III activities would be longer (18 months to 2 years) and would undermine the goals of providing primitive and unconfined recreation experiences for visitors for a minimum of two recreational seasons. The pilot testing facility would be located within one-half mile of the main visitor access road through the recreation area and into the western side of Canyonlands National Park. This activity would degrade visitor experience in the Orange Cliffs portion of the recreation area (affecting a total of 3,500 visitors) and probably preclude hiking and camping in the affected areas.

Phase IV would conflict with present NPS management objectives for the Orange Cliffs area within Glen Canyon National Recreation Area (USDI, NPS, 1977), as well as legislative objectives for the Horseshoe Canyon and Maze areas within Canyonlands National Park (Senate Report on P.L. 92-593, SR 156, 1971). The present management objectives for the area would be unachievable for up to 160 years, and perhaps for 5-70 years more, since the area is of a type that typically is slow to recover from man-caused disruptions.

During the operational life of the project, visitors seeking primitive and undeveloped recreation, with remoteness and self-reliance as principal elements of the outdoor experience, would find these values lost or greatly diminished on NRA lands. In addition, spillover effects would occur in the western portions of Canyonlands National Park in areas recommended for wilderness designation. Factors contributing to the diminishing of such resource values include the paving of the road into the project area, which would facilitate vehicle traffic and increase visitation to the area, as well as facilitate the movement of the applicants' vehicles; the construction of a large synfuels facility within and immediately adjacent to the NRA boundary; and sound, visual, and odor intrusions due to extraction, upgrading, and the increase in vehicular traffic.

The number of visitors desiring the services of private outfitters who specialize in backcountry trips would likely decrease. There is currently one outfitter with a permit for backcountry use in the Orange Cliffs and Maze areas. The outfitter serves less than 100 persons per year (pers. comm., Jones, Canyonlands National Park 1983). A major increase in human activity in the proposed federal lease unit, whether due to industrial activity or to increased visitation, would detract from experiences that are dependent upon low levels of human activity. However, paving the road could encourage additional visitation by those interested in motor touring rather than backcountry use.

Increased visitation to the general area as a result of paving the dirt road from Temple Junction (UT 24) into the project area was predicted using a visitor analysis compiled after roads into Canyon de Chelly, Navajo, and Cliff Dwellings national monuments were paved (USDI, NPS 1983). The average visitation increase after road paving was 953 percent. If this percentage is applied to the 1982 visitation figures for the Hans Flat ranger station, 32,980 visitors would be expected annually after the access road is paved into the project area. Because 97 percent of the recreation area and the park visitation is currently from outside the southeastern Utah region, the bulk of the increased visitation would also come from other states or other parts of Utah. As the project would cause a long-term population increase in southeastern Utah of approximately 66 percent, similar increases in local visitor use could also result. Additionally, visitor demand would shift from undeveloped backcountry use toward more developed types of recreational use, perhaps necessitating additional recreational development and visitor services in the area.

Hunting, particularly of larger game species such as deer and antelope, is an important recreational use of the lands within and near the proposed unit. Habitat disruptions due to vegetation removal and changes and other intrusions (such as increased noise and traffic) could reduce the amount of game available in the area and the likelihood of hunting success, although such effects cannot be quantified at this time. In addition, the planned reintroduction of bighorn sheep (with the goal of eventual reestablishment to the point where hunting could be allowed) would not be possible during the life of the commercial operations.

Deer hunting, in particular, is an important existing local recreational use in the vicinity of the proposed federal lease unit, and deer hunting could be adversely affected during phase IV. In 1982, 97 percent of the deer hunters for deer herd no. 29 were Utah residents; if hunting opportunities or success rates decline as a result of project activities, most of the effect would be felt by Utah residents (see table 15).

Under the BLM's interim management policy for WSAs (USDI, BLM 1982), phases I and II activities could be conducted within the French Spring/Happy Canyon, Horseshoe Canyon, and Fiddler Butte WSAs, if the BLM determines that the nonimpairment management standard can be met. However, adverse impacts to these wilderness values could occur during phase III and definitely would occur during phase IV. No permanent development can take place within the WSAs unless and until Congress takes action to drop these areas from wilderness protection, but development adjacent to these areas would still introduce sight, noise, and odor intrusions into the WSAs. In the potential wilderness areas in the vicinity of the proposed federal lease unit, the eventual upgrading and paving of primary access routes would provide access to existing dirt roads that could serve as jumping off points for offroad vehicle (ORV) use.

Sights and sounds from heavy vehicular traffic would intrude on the northern portions of the Fiddler Butte WSA and the Dirty Devil wilderness area recommended by the NPS if the applicants were to upgrade and use the access route through Poison Spring Canyon and Hatch canyons, either for project area access or for access to auxiliary facilities such as water intakes. Portions of 455,330 acres of potential wilderness could be adversely affected by offsite

activities under phase IV, particularly those portions of four BLM WSAs adjacent to project components and to existing dirt roads and trails (see figure 43). Similar impacts would occur in the recommended wilderness areas in the Orange Cliffs portion of Glen Canyon National Recreation Area and in the Maze district in Canyonlands National Park.

UNAVOIDABLE ADVERSE IMPACTS

Implementing the required federal mitigation measures (see appendix C), including all applicable regulatory control requirements, would reduce impacts of the project as proposed. Those impacts that would remain following mitigation are described in this section. If impacts are eliminated by applying the measures, discussion is omitted.

Geologic Resources

Extensive subsurface fracturing would occur (on up to 38,790 acres) and, as the nature and extent of the fracturing cannot be predicted in advance, subsidence rockfalls and steam blowouts on cliff faces would likely result. Such rockfalls and blowouts could constitute a safety hazard for visitors and would have adverse effects on raptor nesting areas and bighorn escape terrain.

Topographic Resources

Constructing a major industrial facility and sequential development of 18 prospective areas (totaling approximately 35,000 wells over the life of the project), constructing ancillary facilities such as roads, pipelines, and solid waste disposal would constitute major topographic alterations within the proposed unit. Up to 50 million cubic yards of soil (from up to 29,882 acres) would be moved over the life of the project. Such alterations would be highly visible to visitors (see the "Scenic Quality" section).

Water Resources

Water requirements are estimated at 1,679 acre-feet per year, or about 3 percent of the annual flow of the Dirty Devil River at the commercial development stage; this water would therefore not be available for other uses. The proposed federal lease unit is arid, and lack of available water is a major limiting factor for both human and wildlife use; competing uses that require water, such as irrigation, community water requirements, and other energy development projects, would be foreclosed for the life of the project, or up to 160 years.

Little is known about the groundwater regimes in the area, and groundwater is an important source for springs, seeps, and wells that are depended upon by both humans and animals. Development as proposed would disrupt groundwater regimes and could dewater spring and seeps in the vicinity of the proposed unit. There are few alternatives available for water sources, and this is expected to have a significant effect on both humans and animals.

Soils

Approximately 11,953 acres of soils would be totally disturbed during the life of the project. Although the applicants would be required to reclaim areas, reclamation would be difficult and would take time (from 5 to 70 years). The potential for soil loss and erosion, even if reclamation is successful, is significant.

Vegetation

Up to 14,335 acres of vegetation would be removed over the 160 year life of the project (12,081 acres of the vegetation removed would be within mature pinyon-juniper associations). Grassland and shrubland could be reclaimed to its former (pre-operations) state within 5 years if intensive reclamation techniques are applied, but the 84 percent of the unit covered by mature pinyon-juniper vegetation types could not be restored to mature stands for up to 70 years after operations cease. The adverse impact on existing vegetation character and habitat type would be unavoidable for a period of up to 70 years after operations cease within each of the 18 prospective areas. For areas within Glen Canyon where mature pinyon-juniper would be removed, there would be an unavoidable adverse impact on the best example of mature pinyon-juniper woodlands existing within the recreation area.

Wildlife

Up to 38,790 acres of wildlife habitat would be disturbed (in 1,400-acre increments) over the life of the project (up to 160 years for the commercial development stage). An additional unknown quantity of wildlife habitat would be altered by effects such as noise, traffic, increased human intrusion, and elimination of or exclusion from water sources. Planned reintroduction of desert bighorn sheep into the area could not be accomplished during the life of the project, and adverse impacts on existing bighorn populations (including exclusion from the lease unit and its vicinity) would occur for the life of the project, or up to 160 years. Similar impacts (both direct and secondary) on other large species and raptors are expected, and though required mitigation would reduce these impacts, the combined effects of project activities on wildlife and habitat would be significant and unavoidable.

Air Quality

Although the applicants would have to meet regulatory air pollution control requirements to receive any permits, the projected emission rates from 30,000-bpd production as proposed by the applicants would result in exceedances or violations of primary health effects standards (24 hour for sulfur dioxide and 24 hour and annual for particulate matter). For sulfur dioxide, the 24-hour NAAQS exceedance would be a factor of 1.49; for particulate matter, the 24-hour NAAQS exceedance would be 1.52 and the annual NAAQS exceedance would be 2.12.

The project as currently proposed would also cause exceedances of the 3-hour class II PSD increment for sulfur dioxide (by a factor of 1.54) and the 24-hour class II PSD increment for sulfur dioxide (by a factor of 5.83). The short-term class II PSD increment for particulate matter would be exceeded by a factor of 8.28 and the annual class II PSD increment by a factor of 7.42. All maximum concentrations would occur within Glen Canyon. In addition, the 3-hour and 24-hour class I PSD increments for sulfur dioxide would be exceeded by factors of 7.85 and 5.12, respectively, in Canyonlands, as would the short-term and annual class I PSD increments for particulate matter (by a factor of 4.6 and 2.1, respectively). The 3-hour and 24-hour class I PSD increments for sulfur dioxide would be exceeded by a factor of 1.40 and 1.16, respectively, in Arches National Park. Significant degradation of visibility would also occur (particularly in Canyonlands) and would be unavoidable.

Noise

Mitigative measures to minimize adverse auditory effects (such as hearing impairment) would be required of the applicants, but the amount of noise generated due to operation of a 1,940-well field, a refinery-type upgrading facility, and increased road traffic (66 dbA at 1,000 feet from the wellfields and facilities) in an essentially rural, quiet area would be significantly above maximum background levels of 35 dbA and would have an unavoidable impact on both residents and visitors to Glen Canyon, Canyonlands, and BLM WSAs, as well as on wildlife populations in the vicinity of the proposed unit. Noise levels significantly above maximum background would occur within a radius of more than 5 miles of the facilities.

Scenic Quality

Over time, the scenic character of the proposed federal lease unit would change from essentially natural to a landscape where human alteration is predominant. If visitation remains at present levels, over 500,000 visitors (or approximately 3,200 per year) could be adversely affected over the 160-year life of the project by changes in scenic quality. Visual impacts associated with progressive vegetation removal for wellfield development, the upgrading facilities, and ancillary facilities (including roads, pipelines, and waste disposal sites) would be unavoidable and would endure for many years. There would be a loss of scenic values for which the area was designated as nationally significant.

Cultural Resources

Although the applicants would be required to mitigate direct impacts on the most significant cultural resources, the proposed unit is in an area containing one of the highest known concentrations of archeological sites on the Colorado Plateau (an estimated minimum site density of 24 sites per square mile). Given the intensity of development and the cumulative amount of ground disturbance that would occur over the life of the project, destruction of in-context

cultural remains would be significant and unavoidable. A minimum of 2,000 sites would be disturbed over the 160-year life of the commercial development phase. The complex of sites within the proposed Orange Cliffs Multi-Resource National Register property would be irrevocably altered.

In addition, adverse secondary effects due to the influx of a large number of people (both the applicants' employees and families, and increased numbers of visitors and recreation users), ranging from increased wear-and-tear on fragile resources due to unauthorized collection and vandalism, would be significant and unavoidable.

Socioeconomic Environment

The applicants would be required to comply with state of Utah restrictions regarding mitigation of socioeconomic impacts, but there would be a lag time between the initial influx of people (2,400 workers estimated in the initial peak workforce year) into a currently rural and undeveloped region and the construction and provision of necessary infrastructure and services. In addition, the cyclical nature of the project would prompt "boom and bust" cycles (up to 18 of them). A large construction workforce (up to 2,200 construction workers), as compared to an operational workforce (up to 350 operational workers), would be required, and services and infrastructure would either have to be developed to serve this transient population, or shortfalls would result. Local individuals who could obtain employment in project activities would benefit from the project, but those in local communities who are living on fixed incomes or employed in traditional occupations could suffer from local price inflation (particularly in the cost of housing and services). As insufficient workforce currently exists in the region to provide workers for project activities, and as specialized skills would be required, a large influx of outsiders would be expected. Such a large increase in population would essentially destroy the traditional cultural homogeneity of the towns and counties in the vicinity of the proposed federal lease unit.

Land Use

If all required mitigation is imposed, the project as proposed by the applicants would be in conflict with both BLM and NPS land use plans and management goals. The present BLM land use plan classifies the BLM lands within the proposed federal lease unit as category 1 (lease with standard stipulations only), so some of the required mitigative stipulations would not be in conformance with the plan. The NPS, in particular, would not be able to achieve its management and legislative objectives of providing recreational experiences oriented toward unimpeded public enjoyment of scenic, natural, and cultural resources within Glen Canyon or in contiguous portions of Canyonlands.

Recreation and Wilderness Values

Though all required mitigation would be imposed, the project as proposed would have major unavoidable adverse impacts on the type and quality of recreational

experience of visitors to this area of Glen Canyon and the western portions of Canyonlands. Up to 500,000 visitors over the 160-year life of the project (or approximately 3,200 per year if visitation remains at 1982 levels) would be affected. Direct impacts due to placement of project components would occur in Glen Canyon, and indirect impacts due to spillover impacts (i.e., those that do not respect geographic boundaries, such as air emissions, noise, lighting intrusions, and odors) would occur in Canyonlands. Access alternatives are limited due to terrain constraints, and traffic and other access conflicts between the applicants' vehicles and recreationists would be unavoidable.

The desirability of the area for hunting would be reduced, as would hunting success, and the resultant impact on Utah recreationists (in 1982, 97 percent of the deer hunters in the vicinity of the unit were Utah residents) would be unavoidable.

LONG-TERM ENVIRONMENTAL CONSEQUENCES

Relationship of Short-Term Uses of the Environment and Enhancement of Long-Term Productivity

Phases I, II, and III would not under present levels of knowledge have significant long-term effects on the environment or on productivity. Given that the projected life of the tar sand development project if leases are converted would be up to 160 years at the commercial development stage (phase IV), all unmitigated impacts previously discussed must be considered to be long term. In particular, the unavoidable adverse impacts on water resources, wildlife, vegetation, air quality related values (such as visibility), cultural resources, and recreational and wilderness values would be significant and long term.

The short-term goal that would be achieved would be development of a new technology for extraction of a previously inaccessible hydrocarbon fuel resource. Up to 30,000 bpd of bitumen (20,700 bpd of syncrude to market) would be produced during the commercial development phase; this would contribute to the total amount of domestic petroleum products available in the U.S., providing that existing technological and economic problems can be overcome.

Irreversible/Irretrievable Commitments of Resources

Irreversible and irretrievable commitments of resources resulting from lease conversion and tar sand development as proposed in alternative 1 are presented in table 42.

Table 42: Irreversible/Irretrievable Commitments of Resources

Resource	Resource Commitments
Energy and Minerals	Bitumen removed from the tar sand deposit would be consumptively used, constituting an irreversible and irretrievable resource commitment.
Water Resources	Water used for tar sand development would not be available for other uses for up to 160 years, and would be irreversibly and irretrievably committed for that time period.
Soils and Vegetation	Soil losses due to erosion and vegetative production lost due to changes in land use would be irretrievable losses.
Wildlife	Wildlife habitat and production (particularly big game and raptors) within the proposed unit would be irretrievably lost for up to 160 years; such loss could be irreversible for some species (particularly eagles and bighorn sheep).
Scenic Quality	Due to the large-scale and permanent changes in topographic features and the long-term changes in vegetative cover and growth patterns, irretrievable impacts on the landscape character (a change from primarily natural and undeveloped to primarily altered and industrial) and the scenic resources would result.
Cultural Resources	Destruction of in-context archeological remains would be unavoidable as the project progresses; such loss of data and resources is permanent, irreversible, and irretrievable.
Socioeconomic Environment	Changes in the character and cultural composition of the surrounding rural communities and counties would be irreversible.
Land Use	For BLM lands, several other multiple uses (other than mineral development), notably recreational use and grazing, would be precluded during a part or all of the project's 160-year lifespan. For NPS lands, the primary management purpose of providing primitive and unconfined recreation would not be achievable on at least 54,456 acres for up to 160 years. These would constitute an irretrievable commitment of the land base to a single or subordinate purpose for a long period of time.

Resource	Resource Commitments
Recreation and Wilderness Values	The amount of land where one could go to experience solitude or enjoy primitive and unconfined recreational experiences or to hunt would be reduced by at least 54,546 acres; the change in character of the recreational lands from primarily undeveloped and natural to primarily industrialized would be irreversible.

ALTERNATIVE 2A: CONVERT LEASES WITH ADDITIONAL PROTECTIVE RESTRICTIONS

Alternative 2A assumes a production rate of 5,000 bpd and applies the general protective restrictions (see appendix C) and the additional protective restrictions for sensitive resources (see table 4 and figures 9-18).

Phases I and II would generate impacts that are not substantially different from those discussed in alternative 1, and the discussion of those impacts is not repeated here. However, the phase I coreholes and 12 of the 15 phase II coreholes would require location adjustments to conform with the protective restrictions under alternative 2A. If new corehole and access route locations are chosen that are in conformance with the standard and the additional protective restrictions, the impacts of phase I and II activities would be minimal.

Phase III project design and location adjustments would also be required to conform with the standard and additional protective restrictions. Wherever located, the phase III facilities would generate impacts similar to those discussed in alternative 1, except as specifically discussed in this alternative.

Phase IV activities analyzed under alternative 2A would apply the same technology as described by the applicants in the plan of operations (see appendix A), but would be reduced both in area of application and in rate of production. All restrictions would be applied, and the resultant reduction in impacts and residual unmitigated impacts are discussed for each of the natural, cultural, and socioeconomic resources.

IMPACTS ON NATURAL RESOURCES

Geologic Resources

Phase IV activities under alternative 2A would change the chemical composition and structural characteristics of the tar sand host (the White Rim sandstone) underlying the proposed federal lease unit. The causes and nature of the changes would be as described for alternative 1, but the maximum areal extent of the changes within the extraction zones would be reduced from 38,790 to approximately 15,327 acres (see figure 8).

Changes in the chemical and structural properties of the host rock could result in subsidence, which would be noticeable at the surface if rock stresses affect existing fractures or result in rockfalls on cliff faces. The potential for cliff edge fracturing would be reduced by maintaining of a 500-foot buffer between the injection wells and cliff edges (see figure 11). Changes in subsurface geology would have secondary effects on groundwater, as discussed in the "Water Resources" section.

Topographic Resources

As discussed in alternative 1, constructing wellfields and upgrading facilities and associated activities, such as road building, would alter the topographic features within the proposed federal lease unit. However, applying the restrictions would prevent operations on slopes greater than 33 percent, protecting 12,910 acres. These particular restrictions would minimize large cuts-and-fills and would, consequently, reduce the amount of topographic disturbance (see figure 9).

The maximum amount of active topographic disturbance at any one time would be reduced from approximately 1,400 acres to 265 acres. Over the life of the project, up to 23,541 acres could be modified for mounded roadfills, ditches, leveling for pipelines, stockpile and material mounds, solid waste disposal sites, and filled and leveled areas for construction of ancillary facilities. Small quarrying operations for gravel and other construction, road, and pad maintenance could be necessary in the vicinity of the proposed unit. Although the applicants would be required to reclaim these areas, the original topographic contours would not be restored.

Paleontological Resources

As discussed in alternative 1, extraction zones could, during phase IV, extend into areas where there are paleontological resources. The overall reduction in surface disturbance due to applying the additional protective restrictions would also reduce the likelihood of direct disturbance of these resources, but the exact amount of this reduction cannot be quantified. Similarly, a reduction in the number of people in the area (due to restrictions that would reduce employment and project duration) could cause an unquantifiable reduction in secondary adverse effect, such as increased collection and vandalism. Though both direct and secondary impacts on paleontological resources would still probably occur under this alternative, these resources are currently not a major known resource aspect within the proposed unit, so such effects would be relatively minor.

Energy and Minerals

During phase IV operations, the energy efficiency would remain at about 44.5 percent, but the total loss of potential energy over the life of the project could occur on up to 23,541 acres. The relative amounts of resource extracted and left in the ground cannot be quantified, since the extent of the resource and the amount that could be recovered is unknown. The production rate (5,000 bpd) would be the same as for alternatives 2B and 2C, but the duration of operations could differ.

As in alternative 1, recovery of uranium resources would be precluded in areas where tar sand is being actively extracted. The areal extent precluded at any one time would be reduced from 1,400 to 265 acres. Any subsequent underground mining of uranium ore could require the use of larger pillars; therefore, a

portion of any uranium ores present could not be recoverable as a result of tar sand extraction activity. The exact loss cannot be quantified, but it is not expected to be major.

Water Resources

As discussed in alternative 1, surface disturbances associated with the progressive phase IV development of wellfields, roads, and upgrading facilities could result in increased runoff and erosion. Applying restrictions designed to protect the surface recharge areas of springs, seeps, and wells by a one-half-mile buffer (see figure 12), which is subject to adjustment as monitoring establishes the most appropriate distance, would eliminate 4,420 acres from development, minimizing adverse effects on surface recharge areas. Applying the standard requirements for erosion control and design of nonoverflowing storage and surge ponds would minimize the possibility of spills and consequent degradation of surface waters, but, as no facility can ever be engineered so there is absolute certainty of no spilling or failures, the probability of surface water degradation would still exist.

As in alternative 1, constructing a water supply pipeline in Happy Canyon or in one of the other major drainages to the Dirty Devil River would contribute to sediment load to and within the river during construction and if there are any breaks during the operational life of the pipeline.

Restrictions that reduce the production rate would also reduce the makeup water requirement (175 gpm for 5,000 bpd total production vs. 1,050 gpm for 30,000 bpd under alternative 1). Makeup water needs would be reduced from 1,679 to 280 acre-feet annually. The reduction in water use would result in a reduction of average silt disposal requirements from 170 cubic yards per day in alternative 1 to approximately 28 cubic yards per day. As the total volume of water and silt disposal over time is dependent upon the total project duration, and as total project duration cannot be calculated at this time, these volumes cannot be accurately quantified. Assuming for analytical purposes that phase IV operations would endure for a minimum of 50 years, at least 14,000 acre-feet of water would be required as would disposal of 500,000 cubic yards of silt. Because the silt would likely be finer and contain more soluble salts than the native sandy soils, the silt would be more subject to erosion and more difficult to revegetate than the native soils. Since successful revegetation would be a major erosion control technique, erosion of the silt could be a continuing problem.

The withdrawal of 175 gpm (280 acre-feet annually) from the Dirty Devil River would be about 0.5 percent of the average annual flow of the river. Using an average TDS of 1,500 to 2,000 mg/l (or 2.0 to 2.7 tons per acre-foot), the amount of salt removed would be 560 to 760 tons annually. As the flow change within the entire Colorado River system would be negligible, the calculated theoretical annual benefit to downstream users due to salt removal would be $30,000 to $39,000 (USDI, GS 1983). Since this is well within the uncertainty limits of the calculation method used, no firm conclusions can be drawn on whether a real benefit would accrue.

As discussed in alternative 1, downward water leakage from upper formations to lower formations could occur during phase IV, particularly during construction. At an average production rate of 30 bpd per production well, each producing area would require a total of 308 wells (141 steam injection, 167 production wells) to maintain a project production rate of 5,000 bpd of bitumen, assuming an average downward leakage rate of 1 gpm per well, approximately 490,000 gallons per day (gpd) of downward leakage would occur as long as the connection between aquifers is open. The effects of such depletion of the upper zones could adversely affect flows in existing springs and seeps on or near the mesa tops. Because the characteristics of the groundwater regime within the proposed unit are not well defined at this time, although the additional protective restrictions would minimize potential impacts on springs and seeps, it cannot be stated with certainty that no adverse effects on flows would occur.

The one-half-mile buffer around springs, seeps, and wells would minimize the possibility that uncontrolled steam excursions or undesirable fracturing would adversely affect flows.

Steam injection to mobilize the tar would hydrothermally alter the arkosic sandstone matrix of the White Rim and could form hydrated and more mobile materials. Since the areal extent of tar sand extraction would be reduced from a maximum of 1,400 acres to 265 acres at any one time, the extent of local groundwater reduction at any one point in time would be similarly reduced. However, extraction could occur on up to 23,541 acres (15,327 acres within extraction zones) over the entire life of the project, and the cumulative alteration over time would amount to about two-thirds of that occurring in alternative 1. Using the same assumptions on volume of water lost to the formation during the life of the project as discussed in alternative 1, about 98,000 acre-feet of process water could be added to the local system. Groundwater gradients would, therefore, be steeper than normal, hastening the migration of groundwater from the immediate vicinity of the extraction zone. One of the consequences of steam injection would be the mobilization and transport of hydrocarbons (chiefly light ends) and other minerals to the groundwater in the White Rim. Migration of undesirable constituents into previously unaffected areas could occur.

Under a production scenario of 5,000 bpd of bitumen, concentrated wastewater volume would be reduced from 150 gpm to 25 gpm; as discussed in alternative 1, this concentrated wastewater stream would be injected to a suitable, but as-yet unidentified, underground formation. The reinjection zone has not been identified, and the potential hydrologic impacts due to wastewater disposal cannot be quantified. Qualitatively, deleterious effects on groundwater in areas in and adjacent to the proposed federal lease unit could occur within a few years after operations commence. However, as water quality within candidate reinjection zones would initially be of poor quality, wastewater reinjection is not expected to have a major adverse effect.

Applying the restriction on development within a 1-mile radius of the Hans Flat ranger station (see figure 13) would minimize the possibility of effects on the quantity or quality of water in the NPS well at the ranger station.

Soils

Under the lower intensity development scenario postulated for alternative 2A, the total amount of acreage available for development would be reduced from a maximum of 54,456 acres in alternative 1 to a maximum of 23,541 acres. The quantity of soil actually affected within the 18 prospective areas would amount to 13,100 acres (16,782 acres less than in alternative 1). The major benefit under this alternative is the elimination of surface-disturbing activities on the Begay and Mido soils that (1,565 acres) have the highest wind erosion hazard potential of any soils within the proposed unit (USDI, SCS 1983; see figure 6). Although avoiding these soils would reduce overall wind erosion, all soils within the project area are susceptible to erosion when disturbed. Also, 2,204 acres of Channery fine sandy loams of the Rizno series could still be developed, and these soils have the highest water erosion potential of any within the proposed unit (USDI, SCS 1983). Other protective restrictions, such as preventing operations on steep slopes (reducing developable acreage by 12,910), would reduce overall soil loss from the project area by as much as 44 percent during the life of the project.

Table 43: Disturbance by Soil Series

Soil Series	Acres Subject to Development	Net Acres Disturbed
Begay	1,370	548
Rizno (Channery)	2,204	882
Rizno (Warm)	1,731	692
Mellenthin	5,490	2,196
Arches	1,177	471
Travessilla	1,028	411
Mido	0	0
Farb	51	20
Otero	18	7
Badland	31	12
Total	13,100[1]	5,239[2]

[1]Acres of soil within prospective areas #1-#17, #22, and a portion of #23 only.
[2]Acres of soil significantly disturbed or removed by operations using a 40 percent disturbance factor.

If all the soil is removed to bedrock as proposed by the applicants, wherever soil disturbance is necessary within each extraction zone and is stockpiled, assuming an average soil depth of 1 foot and a bulking factor of 0.3, approximately 120,000 cubic yards of soil would be stockpiled onsite for each extraction zone. As discussed in alternative 1, stockpiling of soils for long periods of time could affect soil fertility, which could contribute to problems in reclamation and revegetation.

Damage to cryptogamic soil crusts by sulfur dioxide emissions would be lower under this alternative (the assumptions explained in the "Air Quality" section state that sulfur dioxide emissions would be about one-sixth those experienced in alternative 1. However, amounts of sulfur dioxide sufficient to damage the lichens that form the crusts could still be emitted. It is not known just how this could affect the integrity of the crust or its soil-binding abilities, or how much additional soil loss would result from loss of the lichens.

Completion of each well would yield an average of 26 cubic yards of drill cuttings to the top of the White Rim, and an additional 2½ yards of cuttings from the White Rim. Each field of 308 wells would thus yield an estimated 8,800 cubic yards of cuttings. Disposing of that volume of cuttings in pits, as proposed by the applicants, would not be feasible due to the shallowness of soil cover in many portions of the proposed federal lease unit. Cuttings from above the White Rim (an estimated 8,010 cubic yards per wellfield) would be similar in character to the native soils and could be disposed of by spreading them out over the entire wellfield acreage (if the cuttings were evenly distributed in a 2-inch layer, they would cover approximately 30 acres), or by mixing them with the stockpiled soils. Because cuttings from the White Rim (an estimated 790 cubic yards per wellfield) would probably contain hydrocarbon constituents that could inhibit soil fertility, the cuttings could not be disposed of by spreading them over the soil surface. In all cases, the cuttings would decompose to a very fine particulate matter, and, if not properly disposed of and stabilized would be very susceptible to wind and water erosion.

Reclamation would still be difficult on the disturbed areas, since all soils within the proposed unit are rated as poor or very poor for reclamation potential (USDA, SCS 1983). Reclamation of the area would be possible but would require intensive efforts to ensure success. In addition, certain types of disturbances could present special reclamation problems. For example, boiler waste disposal areas could be difficult to reclaim because there are no extensive amounts of native soil that could be used to mix with or blanket the boiler waste.

Vegetation

Constructing the phase IV upgrading facilities would require removing all vegetation on the 40-acre site for the life of the project. Because of siting uncertainties, quantification of vegetation loss by type is difficult, but the pinyon-juniper woodland and pinyon-juniper shrub woodland (sagebrush) types would be the majority of vegetation lost.

Road upgrading and constructing ancillary facilities (such as the water supply pipeline and product pipelines) would also result in the destruction of approximately 600 additional acres of vegetation.

Total vegetation removed within the prospective areas over the life of the project (assuming that, on average, 40 percent of the vegetation would be removed as each prospective area is developed) would be approximately 8,576 acres. Some disturbance of the remaining 12,863 acres within the prospective areas would also occur, but the exact type and amount of disturbance cannot be quantified at this time. The amount of vegetation disturbed at any one time

would be reduced from 1,400 acres in alternative 1 to 265 acres. The major benefit under this alternative is that approximately 12,451 more acres than in alternative 1 of pinyon-juniper woodland would be protected from major disturbance by the additional restrictions. Table 44 shows anticipated disturbance by vegetation type throughout the developable portion of the project area.

Table 44: Disturbance by Vegetation Type

Vegetation Type	Acres Subject to Development	Net Acres Subject to Removal
Badlands	387	155
Blackbrush shrubland	1,768	707
Pinyon-juniper shrub/woodland (blackbrush zone)	7,115	2,846
Pinyon-juniper shrub/woodland (sagebrush zone)	2,354	942
Pinyon-juniper woodland	7,251	2,900
Sagebrush shrubland	1,467	587
Slickrock woodland	404	162
Slope vegetation	693	277
Canyon riparian	0	0
Total	21,439	8,576

Note: Figures used are estimates only due to uncertainty of site locations.
[1]Acres of vegetation type within prospective areas #1-#18, #22, and #23 only.
[2]Acres significantly disturbed or removed by operations assuming a 40 percent disturbance factor.

Surface-disturbing activities would not affect any known federally listed or proposed threatened or endangered plant species. However, prior to any surface-disturbing activities the lessees would be required to perform a site-specific threatened or endangered plant species inventory, in accordance with the threatened and endangered species survey and consultation requirements discussed in alternative 1.

Reclamation of disturbed areas would be difficult and require applying intensive measures over many growing seasons. Irrigation, planting of potted shrubs, seeding, and reseeding with native species, site preparation, and fencing to exclude livestock and wildlife until vegetation can become established are all measures that would be necessary to ensure reclamation success.

Wildlife

Under phase IV of alternative 2A, the prospective areas would not be completely denuded, but the presence of closely spaced wells and ancillary equipment would

essentially destroy 265 acres of wildlife habitat at any one time. All vegetation in these affected areas would not be physically removed, and some small species, such as rodents and rabbits, could probably manage to survive in reduced numbers in this degraded habitat, as would some bird species.

The causes and extent of impacts on big game, nongame, raptors, and threatened and endangered species would be similar under this alternative to those described for alternative 1, but the maximum amount of habitat directly disturbed at any one time would be reduced from 1,400 acres in alternative 1 to 265 acres, or 0.02 percent of the total habitat within the unit. Total habitat disturbance could be up to 23,541 acres (36 percent of the entire 66,040-acre lease unit proposed by the applicants). The nonimpairment standard for WSAs would provide protection of habitat within the WSAs from intense development activities until such time as Congress acts to drop the WSAs from consideration as wilderness; if the areas are dropped from consideration, full development (subject to restrictions to protect sensitive resources) could occur, with consequent habitat degradation for all species.

Short-term effects on wildlife species would occur due both to the sporadic nature of wellfield activities and to cyclical or seasonal wildlife use patterns. The restriction limiting activities within the zone of influence around active raptor nests (3,200 feet, or 1 km) during nesting season would mitigate adverse effects on raptors (see figure 15). However, during operational stages of phase IV, a seasonal limit on activities within a nest's zone of influence could result in a complete shutdown of the applicants' activities.

As discussed in alternative 1, acute detrimental effects on wildlife could occur during spills or upset conditions if amounts of harmful materials were released to the surrounding areas in sufficient concentrations and volumes to be life-threatening.

Reintroduction efforts designed to assist desert bighorn sheep populations in recovering from critically low levels would be at risk or totally infeasible for the duration of phase IV activities, and since activities under alternative 2A could endure for a longer time period than in alternative 1, such adverse effects could also endure for a much greater time period.

Minor detrimental effects on deer and antelope within the proposed federal lease unit could also occur under alternative 2A. The proposed unit is not ideal antelope range, as the cover type is largely woodland or woodland-shrub, and antelope prefer open rangeland. A few individual antelope could be adversely affected by phase IV activities, including increased traffic on the roads into the lease unit, but these impacts are not expected to affect the viability of the San Rafael herd in the vicinity of the unit. Individual deer could also be adversely affected; although there likely are more deer within the lease unit than antelope, the numbers of deer that could be affected cannot be quantified. A portion of deer herd no. 29 could be displaced from the portion of the herd's range lying within the proposed unit, but such displacement is not anticipated to have a major effect on overall herd viability.

Water for steam generation and other onsite processing and domestic needs would be obtained from the Dirty Devil River, to the west of the proposed federal

lease unit at an estimated rate of 280 acre-feet annually. Although this quantity of water is only an estimated 0.5 percent of annual average flow, at certain times of the year, some reaches of the Dirty Devil River are dry or nearly dry. Further flow reductions in the Dirty Devil could adversely affect the viability of the razorback sucker, a fish proposed for listing as an endangered species (Clark, FWS, pers. comm. 1983). Sufficient information is not available at this time on either the applicants' water withdrawal plans or on habitat for the razorback sucker, so no determination of effect on the razorback sucker can be made at this time. As discussed in alternative 1, complete surveys would be required when the applicants submit a complete, site-specific proposal for water withdrawal, and a determination would be made at that time whether section 7 consultation with the FWS for endangered species compliance would be required prior to any activity by the applicants.

The endangered humpback chub and Colorado squawfish, lower basin fish species, could also be threatened by water withdrawals from the Dirty Devil River sufficient to affect flows in the lower Colorado drainage, but these effects on the lower basin are not anticipated under this project, and effects on the humpback chub are not anticipated.

Air Quality

The air quality analysis of alternative 2A differs from the air quality analysis of alternative 1 only in that it is based on the assumed lower production level of 5,000 bpd. However, the following critical assumptions are made to approximate a corresponding emissions scenario:

There are no differences in the phase I, II, and III emissions from those discussed in alternative 1; therefore, no differences in air quality impacts are expected for alternative 2A.

The source configuration (stack heights, source locations, emission parameters, and control technology) remain unchanged from those discussed in alternative 1, so that concentration estimates for this alternative can be calculated by reducing the alternative 1 concentrations by one-sixth (the ratio of 5,000 bpd to 30,000 bpd).

A linear relationship between production and pollutant emission rates is assumed (i.e., pollutant emissions from a 5,000-bpd production scenario would be one-sixth of those from a 30,000-bpd production scenario).

The results presented for this alternative, therefore, are not based on new model runs but were computed by reducing the concentration estimates for phase IV in alternative 1 by a factor of one-sixth.

Impacts on class II areas are summarized in table 45. All maximum concentrations calculated for sulfur dioxide, particulate matter, and nitrogen dioxide occur within Glen Canyon National Recreation Area. Expected increases in sulfur dioxide were modeled based on extracted bitumen with sulfur contents of 2, 4 and 6 percent. However, as discussed in alternative 1, the 4 percent sulfur content was assumed to be the most representative of bitumen occurring

Table 45: Pollutant Concentrations Calculated for 5,000-bpd Production

Pollutant	Averaging Time	Concentration (ug/m^3) Assumed Background*	Bitumen (% sulfur)	Project Contribution	Total	NAAQS	PSD Increment (Class II)	PSD Increment Exceedance Ratio**
SO_2	3 hours	13	2	66	19	1,300	512	.13
			4	131	144			.26
			6	197	210			.39
	24 hours	13	2	44	57	365	91	.49
			4	88	101			.97
			6	133	146			1.5
	annual	13	2	2	15	80	20	.1
			4	4	17			.2
			6	6	19			.3
Particulates	24 hours	90		51	141	260	37	1.38
	annual	19		24	43	75	19	1.26
NO_2	annual	13		13	26	100	--	.13

Note: All calculated maximum concentrations are located in Glen Canyon National Recreation Area.

* See table 18.

** Exceedance Ratio = calculated concentration/PSD increment, except for NO_2 where ratio = NO_2 concentration/NAAQS. Ratios greater than one indicate that the increment or standard may be exceeded.

in the Tar Sand Triangle, and only the calculated values for 4 percent sulfur bitumen are discussed in this section.

The results (in table 45) indicate that a lower production level with attendant decreases in emissions would reduce the ambient concentration estimates significantly from those discussed in alternative 1. No exceedances of NAAQS or of sulfur dioxide PSD increments are expected. However, emissions reductions (under the assumptions previously listed) were not sufficient to show compliance with the particulate matter PSD increment, which show exceedances of 1.38 and 1.26 times the increment for averaging times of 24 hours and annually, respectively.

Impacts to neighboring class I areas could also occur under this alternative (see table 46 for a summary of impacts on class I areas). As discussed for class II areas, concentrations would be significantly reduced under the 5,000-bpd production scenario. An exceedance of the 3-hour sulfur dioxide class I PSD increment (by a factor of 1.3) would still occur in Canyonlands National Park. No expected adverse impacts on air quality related values are expected (see the discussion in the "Environmental Consequences" section of alternative 1).

The concentration calculated for Arches National Park and Capitol Reef National Park would be so low compared to the concentration estimates for alternative 1 that adverse impacts on air quality related values are not anticipated.

As for alternative 1, no significant increase in ozone concentrations are expected as a result of phase IV operations. Similarly, emissions of hazardous and other criteria and noncriteria pollutants are not expected to cause adverse effects.

Under this alternative, possible adverse effects on air quality related values due to phase IV activities include impacts on visibility. Because the source did not pass the level 1 screening analysis at the 30,000-bpd production rate for alternative 1, an additional screening analysis (level 2) was done to assess whether there would be potential adverse impacts on visibility at a 5,000-bpd production rate.

Emission rates for a 5,000-bpd production rate were assumed to be one-sixth of those for a 30,000-bpd production rate scenario. The specific indices of visibility degradation analyzed (see alternative 1 for a discussion of plume-observer geometry, time, and meteorological assumptions) were contrast of the plume against the sky (plume contrast) and change in sky/terrain contrast caused by the plume (sky/terrain contrast reduction). The results (see table 47) for stable conditions show that the threshold for plume/sky contrast perceptibility would be exceeded at four of the five targets, but a significant sky/terrain contrast reduction would be expected only at Ekker Butte. The lower production rate scenario passed the level 2 screening tests for neutral conditions.

Table 46: Pollutant Concentrations Calculated for 5,000-bpd Production at Canyonlands, Arches, and Capitol Reef National Parks

Pollutant	Averaging Time	Concentration (ug/m^3) Assumed Background*	Bitumen (% sulfur)	Project Contribution	Total	NAAQS	PSD Increment (Class I)	PSD Increment Exceedance Ratio**
Canyonlands National Park								
SO_2	3 hours	13	2	16	29	1,300	25	.66
			4	33	46			1.3
			6	49	62			1.97
	24 hours	13	2	2	15	365	5	.43
			4	4	17			.85
			6	6	19			1.28
	annual	13	2	0.1	13	80	2	.05
			4	0.2	13			.1
			6	0.3	13			.15
Particulates	24 hours	90		8	98	260	10	.77
	annual	19		2	21	75	5	.39
NO_2	annual	13		.05	14	100	--	.005
Arches National Park								
SO_2	3 hours	13	2	3	16	1,300	25	.1
			4	6	19			.23
			6	9	22			.35
	24 hours	13	2	0.5	14	365	5	.1
			4	1	14			.19
			6	1.5	15			.29
	annual	13	2	0.008	13	80	2	.005
			4	0.02	13			.008
			6	0.033	13			.015
Particulates	24 hours	90		0.5	91	260	10	.05
	annual	19		0.008	19	75	5	.002
NO_2	annual	13		0.025	13	100	--	.0003
Capitol Reef National Park								
SO_2	3 hours	13	2	2	15	1,300	25	.08
			4	4	17			.16
			6	6	19			.24
	24 hours	13	2	0.27	13	365	5	.054
			4	0.5	14			.1
			6	0.78	14			.16
	annual	13	2	0.005	13	80	2	.0025
			4	0.01	13			.005
			6	0.02	13			.01
Particulates	24 hours	90		0.23	90	260	10	.023
	annual	19		0.005	19	75	5	.001
NO_2	annual	13		0.02	13	100	--	.0002

* See table 18.

** Exceedance Ratio = calculated concentration/PSD increment, except for NO_2 where ratio = NO^2 concentration/NAAQS. Ratios greater than one indicate that the increment or standard may be exceeded.

Table 47: Level 2 Visibility Analysis for Phase IV (5,000 bpd)

Target	Wavelength	Plume Contrast	Contrast Reduction
Big Flat Top	.40	-0.100	0.004
	.55	-0.046	0.008
	.70	-0.029	0.011
Henry Mountains	.40	-0.258	0.002
	.55	-0.145	0.014
	.70	-0.093	0.026
Dark Canyon Plateau	.40	-0.123	0.009
	.55	-0.049	0.020
	.70	-0.026	0.028
Aquarius Plateau	.40	-0.161	0.000
	.55	-0.085	0.001
	.70	-0.051	0.004
Ekker Butte	.40	-0.166	0.165
	.55	-0.094	0.094
	.70	-0.057	0.086

Because stable conditions occur in this region 40 percent of the time in each season, and because winds with a southwesterly component can occur as much as 30 percent of the time, the probability of visibility degradation due to a perceptible plume is lower than for alternative 1 (with no consideration given to frequency of occurrence). However, even at the 5,000-bpd production rate, visibility degradation could still occur. Preliminary information indicates that a maximum production rate of 1,800 bpd (under the previous emission and configuration assumptions) would reduce visibility impacts sufficiently so such impacts could be termed insignificant. As discussed in alternative 1, however, additional and more refined analyses would be required to assess the potential for visibility impairment with a greater degree of certainty.

The wet and dry acid deposition rates expected from phase IV activities would result in a total acid deposition rate below an acceptable level of 5 kg/hectare/year (Oppenheimer 1982). Adverse effects due to acid deposition are not expected.

Secondary air quality impacts are those caused by emissions from activities supporting the project, such as increased population and vehicular use in the general project area. The centers of population (Green River in Emery County and Hanksville in Wayne County) that would be the sources of emissions are distant from the project area, and modeling calculations of such emissions were not made. The amount of secondary emissions compared to alternative 1 would be low. As the impact from such emissions is not expected to be significant at the 30,000-bpd production level, it is unlikely to be noticeable for a production level of 5,000 bpd. Both Wayne and Emery counties would retain their essentially rural, clean air characteristics.

Noise

Similar to alternative 1, noise generated by construction activities would recur at intervals during phase IV, as portions of the wellfield are exhausted and new wellfields are drilled. Construction noise usually would not be continuous over a 24-hour period. Because the number of wells being drilled at any one time would be smaller, maximum levels would be lower than for alternative 1 (see table 48 for a listing of maximum decibel levels generated during the construction stage). Total noise generated by construction activities would depend upon how any wells are being drilled at once, the type of equipment used, and whether construction activities are carried on simultaneously with operations. The typical noise levels (47 dbA) calculated for a receptor 1,000 feet from the construction activity (see appendix G) are significantly above maximum background noise levels typical of rural areas. Noise levels at the construction stage of a smaller scale phase IV are low enough so adverse auditory effects on visitors and residents are not expected. Workers in the area who are exposed to excess noise levels would be required to wear adequate hearing protection.

Table 48: Noise Levels for Phase IV

Receptor Distance From Site	Construction (daytime only) L_{eq} = 96 dbA	Operation (day and night) L_{eq} = 107 dbA
250 feet	59 dbA	70 dbA
500 feet	53	64
1,000 feet	47	58
1 mile	32	43
2 miles	26	37
5 miles	--	30
10 miles	--	--

Nonauditory effects on both humans and wildlife populations are expected to be similar to those discussed in alternative 1. Since phase IV development would still require cyclical exhaustion and reconstruction of portions of the wellfield and relocation of other facilities, these effects would recur up to 18 times during the life of the commercial development phase.

Applying a 1-mile no-development buffer would provide some distance attenuation and would thus reduce adverse nonauditory effects for the residents at Hans Flat ranger station. However, depending upon the exact location of facilities, adverse nonauditory effects on visitors and wildlife could still occur.

If relocating phase IV activities is required under alternative 2A, such adverse nonauditory effects on residents and visitors could be minimized by applying restrictions on where noise-generating facilities could be located in relation to residential and visitor use areas; however, it would not be possible to completely mitigate such effects.

Wildlife in the immediate vicinity of the operation are expected to employ avoidance techniques, so no adverse auditory effects on wildlife are expected. However, nonauditory effects such as disruption of feeding, breeding, and migration are likely to occur within wildlife populations near the operations facilities. The relative sensitivities and amount of disruption that would occur in wildlife populations are not known.

As for alternative 1, noise levels in Green River and Hanksville would increase because of tar sand related heavy truck traffic. During phase IV operations up to 25 heavy trucks per day would pass through Green River or Hanksville, depending upon the main access route into the project area chosen by the applicants. Though the number of trucks per day would be lower in alternative 2A, the duration of the operations would likely be longer, and the noise generated by trucks would endure for a longer period of time. Peak noise levels from haul trucks traveling at 35 mph or greater would be 86 dbA, measured at a distance of 50 feet from the noise source (EPA 1971). Resultant impacts on the population could include interference with speech and temporary inability to hear speech and disruptions of sleep and concentration. Noise impacts would range from minor annoyance to disruption of normal activities but would not cause serious health problems (USDOT 1978). Green River is currently experiencing relatively high traffic noise levels due to heavy truck traffic; increases in the frequency and magnitude of such noise levels due to tar sand development are but cannot be accurately quantified at this time.

Scenic Quality

As for alternative 1, phase IV activities include intrusive modifications within the lease unit caused by roads, wellfields, buildings, pipelines, heavy traffic, dust, and smoke. Although less land would be disturbed at any one time under alternative 2A, 23,541 acres of land could ultimately be disturbed. Scenic resource and public health safety restrictions on lands within one-half mile of overlooks (1,755 acres) and on approximately 1,965 acres of land with the highest visual exposure from the major overlooks would reduce the impacts on scenic resources within Glen Canyon National Recreation Area, but would not eliminate them entirely (see figure 18). Scenic quality impacts could be totally mitigated only if all operations on the mesa tops above the Orange Cliffs were precluded. Impacts on viewsheds from Canyonlands National Park into the project area would be reduced by limiting activity on 2,455 acres within a scenic buffer area along the Orange Cliffs, therefore minimizing adverse impact on long-range views from the park (see figure 17).

A 200-foot buffer along the Flint Trail provides little visual screening given the terrain type and sparse vegetative cover within the proposed federal lease unit (see figure 14). However, the limited spatial separation could temper the impact somewhat for those recreation area visitors traveling the road. The upgrading plant, if located where proposed, would still be visible from most of the road and from all six of the major overlooks within the national recreation area.

Applying the recommended protective restrictions would reduce development on lands classified under the VRM system (BLM lands) by 10,137 acres. However, 2,185 acres, 2,450 acres, and 4,311 acres of VRM class II, III, and IV lands,

respectively, would still be affected by development under this alternative. The upgrading plant (if located where proposed by the applicants) would also be visible from areas within the French Spring/Happy Canyon WSA.

IMPACTS ON CULTURAL RESOURCES

Historic Resources

Under alternative 2A, applying the no-surface-occupancy restrictions to protect the most sensitive or the most significant concentrations of cultural resources (precluding development on 5,340 acres) would prevent development in the proposed Flint Flat/South Fork Happy Canyon district where the only known historic resource within the proposed federal lease unit is located (see figure 10). Direct impacts on that resource (the Wolverton cabin) are not anticipated.

Indirect impacts attributable to increased numbers of people in the area, such as increased wear-and-tear and vandalism, would still occur. There would be fewer of the applicants' employees within the lease unit, but the increase in the number of visitors due to road upgrading would be similar to that estimated for alternative 1. Any adverse secondary impacts on historic resources would be of similar magnitude to those discussed in alternative 1. As historic resources are a relatively minor part of the cultural resource aspect of the proposed federal lease unit and its surroundings, major adverse effects are not anticipated.

Archeological Resources

As in alternative 1, full production under phase IV would have a major detrimental effect on the area's archeological remains. Although development would be precluded on 5,340 acres containing the highest concentrations of the most sensitive known archeological resources proposed for inclusion in the National Register property, the type and intensity of development (even at a substantially lower production rate) would be incompatible with the goals of site protection, preservation, and interpretation.

Applying restrictions designed specifically to reduce impacts on cultural resources, plus other restrictions that have the practical effect of reducing or preventing surface disturbance, would also reduce direct impacts to known archeological resources. However, up to 23,541 acres could ultimately be disturbed for tar sand development activities. As the site density within the proposed federal lease unit has been estimated at a minimum of 24 sites per square mile, at least 885 sites could be directly affected. As in alternative 1, 38 known archeological sites would be affected if the Flint Trail is upgraded from UT 24 to the Gordon Flats area.

Prior to initiating any surface-disturbing activity, a 100 percent archeological survey would be required. All sites located during the survey would be evaluated for their contribution to the Orange Cliffs Multi-Resource National Register property, and all mitigation would be carried out in accordance with the approved areawide cultural resources mitigation plan (as discussed in alternative 1).

Because air pollutant emissions are expected to be lower under this alternative than for alternative 1, adverse effects on the area's rock art due to stone deterioration, pigment alterations, and staining or darkening would also be reduced. The probability of damage due to air pollutants cannot be quantified at this time, but would be relatively minor.

Although damage to or destruction of individual sites could be reduced by applying appropriate mitigation measures (including avoidance, mapping, collecting, testing, or excavating), the intrusion on and loss of in-context data for the proposed Orange Cliffs Multi-Resource National Register property cannot be mitigated. Over time, in-context archeological remains would be eliminated within the 23,541-acre area that could ultimately be developed under this alternative.

As in alternative 1, indirect impacts on archeological resources would extend well beyond the borders of the lease unit due to the increased numbers of people who would be within archeologically sensitive areas. Although the number of the applicants' employees in the area would be reduced under a lower intensity development scenario, increased visitation due to road upgrading and improved access is expected to be similar to levels discussed in alternative 1. Of special concern are adverse indirect impacts (such as increased vandalism and illicit collection) at nearby National Register sites in Canyonlands National Park. The spectacular and highly significant rock art in the Horseshoe Canyon detached unit of Canyonlands National Park to the north of the proposed project area is expected to receive heavier visitation, with a concomitant increase in vandalism and other destructive effects. Though such adverse effects could be minimized by increased resource protection efforts by the surface managing agencies and through educational programs designed to increase sensitivity for the heritage value of the sites, such impacts cannot be avoided completely.

Although direct impacts on archeological resources would be reduced somewhat under this alternative as compared to alternative 1, the remaining impact would be substantial. Large amounts of in-context data and interpretive potential would be forever lost, which would constitute an irreversible and irretrievable commitment of resources. Both the direct and indirect effects on archeological resources would be of sufficient magnitude to be in conflict with the present management objectives for Glen Canyon National Recreation Area and Canyonlands National Park, and would violate the legislative mandate for preservation of archeological resources within Canyonlands and preservation of scientific remains in Glen Canyon.

IMPACTS ON THE SOCIOECONOMIC ENVIRONMENT

Phases I, II, and III

Phases I and II would have no discernible effect on population or employment. A maximum of 10 persons would be employed for a 2-week period during phase I operations and for a 15-week period during phase II operations. Impacts on the region's socioeconomic climate due to phase I and II activities are not anticipated.

Phase III would be of longer duration and 25 to 30 people would be employed at peak phase III activities; however, impacts on population and employment within the region would be minimal.

Grazing and livestock production impacts in phases I, II, and III would be similar to those discussed in alternative 1. The protective restrictions applied under this alternative (see table 4) would further reduce adverse impacts on the Robbers' Roost grazing allotment (most planned phase I and III activities would occur within this allotment). The widely scattered phase II activities would have a minimal effect on the three allotments.

Impacts on BLM and NPS management and protection operations would be similar to phase I, II, and III impacts discussed for alternative 1. The major administrative burden at phase III would fall on the NPS if activities take place primarily within the national recreation area. The Orange Cliffs area has historically been a remote, undeveloped area with moderate visitation. During phase III, NPS personnel at the Hans Flat ranger station would be required to inform visitors to the area of the changes occurring to help ensure visitor safety and plant/operations security. The effort required is expected to be three times greater than currently required of the staff at Hans Flat and would require at least one additional person (permanent, full-time) stationed at the ranger station.

Phase IV

The 5,000-bpd production rate scenario for phase IV has not been modeled for reductions in impacts on the socioeconomic environment as was the applicants' proposed 30,000-bpd scenario. The impacts that follow are extrapolations of a 10,000-bpd scenario. The 5,000-bpd production level will be analyzed concurrently with public review of this DEIS.

Population and Employment. Under initial phase IV construction and operation within the first of the 18 prospective areas that could ultimately be developed under alternative 2A, the applicants' construction workforce would peak in 1994, and the operational workforce would peak one year later, in 1995. The initial commercial development would increase the population of Wayne and Emery counties by 708. Total employment for the two-county area resulting from the tar sand project is expected to be 345 in 1995. The intensity of activities would be reduced under alternative 2A, but this level of growth is still likely to have a relatively major impact on these two small rural communities.

Personal Income. Personal income projections under the alternative 2A scenario would follow trends identical to those discussed for alternative 1. The proposed project would increase the personal per capita income (PCPI) by 58 percent in the two-county area during the 1995 peak workforce year. The project would raise the PCPI to an estimated $10,937 (in 1980 dollars) in the two counties by 1995, as compared to a projected baseline PCPI of $9,568 without the project. Most of the increase would occur in Wayne County and would likely affect the cost of consumer goods and services, as well as the cost of housing. Local price inflation would probably occur due to the local increase in purchasing power. This localized inflation effect could have a serious impact on long-time residents, especially those living on fixed incomes.

Housing. As discussed in alternative 1, the trend in the number of new households would be affected by the project in much the same way as population. There would be a projected 227 additional households in 1995, and only 68 in the year 2005. This translates into a housing demand of 227 additional units in 1995. Even with existing vacancy rates of 10 to 20 percent, neither communities has adequate and affordable housing to accommodate the expected growth. Wayne County would experience the highest increase in housing demand.

Education. Increases in the demand for teachers and classroom space would still occur under alternative 2A. The number of students is projected to increase faster than the number of classrooms or teachers; there would be an estimated 183 additional students in 1995, with a need for 8 additional teachers and classrooms. The increased numbers of students would increase the pupil-to-teacher ratio and could, therefore, adversely affect the quality of education received by the children of local residents.

Law Enforcement. County law enforcement would require one additional police officer and vehicle under a lower intensity alternative 2A development scenario. An additional 352 square feet of jail space would be required in the peak year of 1995. The increased demand for law enforcement support on NPS-managed lands is expected to double during phase IV.

Fire Protection. Near the processing plant, new fire protection facilities and equipment would be furnished by the applicants. The additional industrial activity and the extraction and upgrading facilities could result in an increase in wildland fires, and fires involving flammable liquids and other hazardous materials could also be expected to occur. Additional fire suppression equipment and training for NPS personnel stationed at Hans Flat would also be required.

Health Care Services. Increases in health care and public safety generated under alternative 2A would be less than those expected in other categories. Neglecting distribution problems, the total number of additional medical personnel required would be quite small; no more than one additional doctor, dentist, or public health nurse, and two additional nurses would be required during the peak year (1995). However, the lack of readily accessible health care services would continue to be a problem for both long-time residents and new workforce and their families.

Public Utilities. As existing water, sewer, and power generation facilities are currently operated at or near capacity, in and around the lease unit,

additional public utility capacity would be required. None of the surrounding communities have public utilities that could be extended into the project area. Hanksville currently has no public sewer, water, or solid waste facilities, and Green River currently has no excess capacity. Sewer, water, solid waste disposal, and power generation facilities would be required both within the proposed federal lease unit and within surrounding communities (particularly Hanksville and Green River).

Attitudes and Lifestyles. As discussed in alternative 1, the local populations of Green River and Hanksville could perceive the tar sand development as an enhancement of their lifestyles due to the increase in employment opportunities and community amenities associated with population increases and higher income levels. Impacts would be reduced somewhat under a lower intensity development scenario, but these communities would still experience a diminution of traditional smalltown cultural values due to the increase in population and the consequent decrease in cultural homogeneity but would gain cultural diversity.

Transportation and Access. Depending upon the main access route chosen by the applicants for a given point in the development of the lease unit, either the dirt access road into the project area from UT 24 at Temple Junction or the unimproved road from UT 95 into the proposed lease unit via Poison Spring and Hatch canyons could be upgraded. Heavy use of these roads by the applicants during phase IV would contribute to the overall degradation of the remote and primitive backcountry experience currently sought by most recreationists who visit the area.

Workforce commuters from Hanksville and heavy truck traffic to Green River would compete with the existing traffic volume on UT 24 and I-70 into Green River. As in alternative 1, during phase IV, heavy truck traffic along UT 24 from Temple Junction to I-70 could exceed the level of service for that road segment. Table 49 presents the maximum increases in vehicle use over 1981 baseline levels that would occur as a result of phase IV activities under alternative 2A.

Table 49: Projected Average Annual Daily Traffic
(Maximum Year Projections -- 1995)

Highway Link	Commuter	Truck	Number of Vehicles (without project) 1981	Number of Vehicles (with project) 1995
UT 24 Hanksville to Temple Junction	390	--	483	873
UT 24 Temple Junction to I-70	218	25	483	726
I-70 UT 24 junction	218	25	2,938	3,181

As discussed in alternative 1, a product pipeline could be required. The impacts of such a pipeline would be assessed if and when the applicants submit a specific pipeline proposal.

Green River could serve as a railhead (Denver, Rio Grande, and Western railroad) for transporting the hydrocarbon product to existing refinery facilities (the closest is in Grand Junction, Colorado). However, this refinery is designed to process specific types of hydrocarbon crudes and is not now able to process syncrude of the type generated from tar sand bitumen extraction.

Grazing and Livestock Production. Under alternative 2A, phase IV activities would reduce the total acreage available for cattle grazing by at least 265 acres at any given point in time. Additional acreage would be in the process of revegetation and reclamation as the development moves throughout the proposed federal lease unit. Since reclamation success could depend upon exclusion of cattle until the newly established vegetation is sufficiently healthy to support grazing, additional acreage would also be effectively removed from grazing. Most of the impact would occur within the Robber's Roost allotment. There would be an estimated loss of carrying capacity on Big Ridge of 25 to 50 AUMs per year (or approximately one cow for eight months per year), depending upon the exact location and configuration of the phase IV facilities. Because the Flint Trail and other roads in the area could be used for project access, the road traffic due to phase IV activities could result in vehicle-cattle collisions. Fencing the road right-of-way to exclude cattle and installing cattle guards would reduce the occurrence of such collisions.

The effects on overall carrying capacity of the three BLM grazing allotments is not expected to be significant, as less than 9 percent each of the Robbers' Roost and Sewing Machine allotments is within the lease unit. Although 33 percent of the Flint Trail allotment is within the unit, that portion is currently unallotted, so no adverse effects are anticipated. As long as the nonimpairment standard is in effect for WSAs, 65 percent of the grazing use on BLM land would remain largely unaffected by operations. For areas where post-operations reclamation is successful, grazing capacity could be increased due to a shift in vegetation from lower to higher forage production types.

As in alternative 1, if water sources are eliminated or if cattle are excluded from water sources by operational activity, the practical effect would be to limit the carrying capacity of the portions of the allotments within the lease Nonconformance with BLM land use management framework plans would be resolved through amendments to those plans. Inasmuch as the NEPA process is a form of planning, land use plan conflicts would be adjusted by decisions made on the basis of this DEIS. A decision by the BLM to implement this alternative would be a decision to alter the existing land use planning decisions. unit to a greater degree than would be assumed based solely on the amount of vegetation disturbance.

IMPACTS ON LAND USE

Under alternative 2A, limited conversion of leases and phase I, II, III, and IV activities would be in general compliance with local and state planning criteria. However, this alternative would not be in conformance with the BLM

existing land use plan because special lease restrictions are being proposed in addition to the standard restrictions required for category 1 lands (suitable for leasing with standard stipulations only).

The scale, scope, and duration of phases III and IV would conflict with the protection of scenic, scientific, and cultural values contributing to the public enjoyment of NPS-administered lands; therefore, these activities would not be in conformance with the land use plans and management objectives for both the Orange Cliffs area within Glen Canyon National Recreation Area and the Maze district of Canyonlands National Park.

IMPACTS ON RECREATION AND WILDERNESS VALUES

Phase IV activities, even of reduced intensity, would conflict with NPS management objectives for the Orange Cliffs area within Glen Canyon National Recreation Area (USDI, NPS 1977), as well as the legislative objectives for the Horseshoe Canyon and Maze areas within Canyonlands National Park (Senate Report on P.L. 92-154, Sen. Rept. 156, 1971). The present management objectives for the area would be unattainable for a long period of time (the life of the commercial-scale project), and perhaps for many years more, as the area is of a type that typically is slow to recover from man-caused disruptions. Although the intensity of impacts would be reduced at any one point in time under alternative 2A, the cumulative impacts on recreation over time would still be significant because 15,338 acres of NRA lands would still be subject to extensive commercial development.

Hunting, particularly of larger game species such as deer and antelope, is an important recreational use of the lands within the proposed federal lease unit. Habitat disruptions due to vegetation removal and changes, and other intrusions (such as increased noise and traffic) could reduce the amount of game available and the likelihood of hunting success, but such effects cannot be quantified at this time. Deer hunting, in particular, is an important local recreational use in the vicinity of the unit that is likely to be adversely affected during the commercial development stage of the proposed project (see table 15).

Visitors seeking primitive and undeveloped recreation would find these values lost or greatly diminished. Factors contributing to the diminishing of such resource values include the paving of the road from UT 24 or UT 95 into the project area (thus facilitating vehicle traffic and increasing visitation to the area, as well as facilitating the movement of the applicants' vehicles); the construction of a synfuel facility within or immediately adjacent to the NRA boundary; and sound, visual, and odor intrusions due to extraction, upgrading, refining, and the increase in vehicular traffic.

Increased visitation to the general area, as discussed in alternative 1, would be the result of paving one or more of the dirt roads into the project area. However, developing an alternative access route from the west could reduce recreational and operational use conflicts on the Flint Trail within Glen Canyon National Recreation Area.

Under the BLM's interim management policy for WSAs (USDI, BLM 1982), phase I and II activities under alternative 2A could be conducted under the constraints

imposed by the nonimpairment management standard within the French Spring/Happy Canyon, Horseshoe Canyon, and Fiddler Butte WSAs. Activities proposed in phases III and IV would not be allowed as long as the nonimpairment standard is in effect.

Impacts on other potential wilderness areas would be similar to those identified in alternative 1. Increased unauthorized ORV use using the existing dirt roads as jumping off points would still occur under this alternative. Since upgrading and paving of primary access routes into the project area would still be required for full development, many of the impacts related to increased access would still occur. Project components, such as the extraction and upgrading plant complex, belt conveyors, pipelines, and heavy vehicular traffic would continue to cause sight, sound, and odor intrusions on BLM WSAs and NPS potential wilderness areas.

ALTERNATIVE 2B: DENY CONVERSION ON BLM WSA LANDS

Alternative 2B assumes a production rate of 5,000 bpd and applies the general protective restrictions (see appendix C) and the additional protective restrictions for sensitive resources (see table 4 and figures 9-18). In addition, 24 leases or portions of leases lying within BLM WSAs within the proposed unit would not be converted (see table 5).

Phases I and II would generate impacts that are not substantially different from those discussed in alternative 1. However, the phase I coreholes and 5 of the 15 phase II coreholes would require location adjustments to conform with the protective restrictions. If new corehole and access routes or methods are chosen that are in conformance with all of the restrictions, the impacts of phases I and II would be minimal.

Phase III facilities would be located within Glen Canyon National Recreation Area in the Gordon Flats area under this alternative, in accordance with standard and additional protective restrictions. Wherever located, the phase III facilities would generate impacts similar to those discussed in alternative 1, except as specifically discussed in this alternative.

Phase IV activities analyzed under alternative 2B would apply the same technology as described by the applicants in the plan of operations (see appendix A), but would be reduced in area of application and in rate of production. The general and additional protective restrictions would also be applied. The nonimpairment standard for WSAs would not, however, be applicable The reduction in impacts after applying the protective restrictions is discussed, as are any residual unmitigated impacts, for each of the natural, cultural, and socioeconomic resources.

IMPACTS ON NATURAL ENVIRONMENT

Geologic Resources

Phase IV activities under alternative 2B could alter the chemical and structural characteristics of the tar sand host rock (White Rim sandstone) underlying approximately 14,090 acres (9,246 acres within the extraction zones) of the proposed federal lease unit, mostly within Glen Canyon National Recreation Area. The changes would be similar to those described in alternative 1. Applying the additional protective restriction of preventing extraction activities within 500 feet of cliff edges (eliminating 5,020 acres from development) would minimize the possibility of subsidence-related rockfalls or steam blowouts on cliff faces. Geologic changes would have a secondary effect on groundwater, as discussed in the "Water Resources" section.

Topographic Resources

As discussed in alternative 1, constructing phase IV wellfields and upgrading facilities and associated activities such as road building would alter topographic features. However, denying lease conversions within the WSAs would ensure that such changes would not occur on 20,091 acres of BLM land within the proposed unit. Protective restrictions preventing operations on slopes greater than 33 percent (applied to 7,960 acres) would minimize the amount of topographic disturbance from the large cuts and fills that would be necessary for construction in such areas.

The maximum amount of active topographic disturbance at any one time for extraction and upgrading would be reduced from approximately 1,400 acres to 265 acres. Over the life of the project, up to 14,090 acres could be modified for mounded roadfills, ditches, leveling for wellpads and pipelines, stockpile and material mounds, solid waste disposal sites, and filled and leveled areas for constructing ancillary facilities. Small quarrying operations for gravel and other construction, road, and pad maintenance materials could be necessary in the vicinity of the proposed unit. Although the applicants would be required to reclaim such areas, the original topographic contours could not be restored.

Paleontological Resources

Prospective areas could, during phase IV, extend into areas where there are paleontological resources. The overall reduction in surface disturbance due to applying the additional protective restrictions would also reduce the likelihood of direct disturbance of paleontological resources, but the exact amount of this reduction cannot be quantified. Similarly, a reduction in total numbers of people in the area due to restrictions that have the effect of reducing employment or duration could cause a consequent unquantifiable reduction in secondary adverse effects such as increased collection and vandalism. Both direct and secondary impacts on paleontological resources would still occur in this alternative, but paleontological resources are currently not a major known resource aspect within the lease unit, so such effects would be relatively minor.

Energy and Minerals

Under the assumptions described in alternative 1, impacts on the present energy and minerals environment would occur under phase IV. Overall, the energy efficiency would remain at about 44.5 percent, but the total loss of potential energy over the life of the project would be reduced to a maximum areal extent of 14,090 acres. The relative amounts of resource extracted and left in the ground cannot be quantified, as the extent of the resource and the amount that could be extracted is unknown. The extracted and upgraded bitumen would be marketed as syncrude and would contribute petroleum products to the total amount available from U.S. sources. The production rate would be the same as in alternatives 2A and 2C, but the duration of operations could differ.

As in alternative 1, recovery of uranium resources would be precluded in areas where tar sand is actively extracted. The areal extent precluded at any one time would be reduced from 1,400 to 265 acres. Any subsequent underground mining of uranium ore could require the use of larger pillars; therefore, a portion of any uranium ores present could not be recoverable as a result of tar sand extraction activity. The exact loss cannot be quantified, but is not expected to be major.

Water Resources

Surface disturbances associated with the progressive phase IV development could result in increased runoff and erosion. Applying the restrictions to protect surface recharge areas for wells, springs, and seeps would eliminate 1,585 acres from development, reducing adverse effects on the surface recharge area. Applying the standard requirements for erosion control, watercourse protection, and design of nonoverflowing storage and surge ponds would minimize the possibility of spills and consequent degradation of surface waters. Accidental spills of hydrocarbons and other process-related substances could also occur. No facility can ever be engineered so there is absolute certainty of no spilling or failures, so a slight possibility of surface water degradation would still exist.

Constructing a water supply pipeline in Happy Canyon or in one of the other major drainages to the Dirty Devil River would contribute to sediment load to and within the river during construction and if there are any breaks during the operational life of the pipeline.

A lower production rate would reduce makeup water requirements (175 gpm for 5,000-bpd bitumen production), and annual water requirements would be reduced from 1,679 to 280 acre-feet annually. Silt disposal would be reduced to 28 cubic yards per day. Assuming for comparative purposes a 50-year project life, 14,000 acre-feet of water would be required, as would disposal of 500,000 cubic yards of silt. The silt would be finer and contain more soluble salts than the native sandy soils, and it would be more difficult to revegetate than native soils. Erosion of the silt and consequent damage to water sources could be a continuing problem.

A withdrawal of 280 acre-feet annually would be about 0.5 percent of the average annual flow in the river. The amount of salt removed could be 560 to 760 tons annually, resulting in a theoretical annual benefit to downstream users of $30,000 to $39,000 annually (USDI, GS 2983). Since this is well within the uncertainty limits of the calculation method used, no firm conclusions could be drawn on whether a real benefit would accrue.

Downward water leakage from upper to lower formations could occur, particularly during construction of phase IV wellfields. Assuming an average downward leakage rate of 1 gpm per well, approximately 490,000 gpd of downward leakage would occur as long as the connection between aquifers remains open. Depletion of the upper zones could adversely affect existing springs and seeps on or near the mesa tops. Although protective restrictions would be applied to minimize potential impacts on springs and seeps, it cannot be stated with certainty that no adverse effects on flows would occur. The one-half-mile radius protective

buffer around springs, seeps, and wells would minimize the possibility that uncontrolled steam excursions or undesirable fracturing would adversely affect flows. Applying the restriction on development within a 1-mile radius of the Hans Flat ranger station would minimize the possibility of effects on the quantity or quality of water in the NPS well at the ranger station.

As discussed in alternative 2A, steam injection would hydrothermally alter the arkosic sandstone matrix of the White Rim, mobilizing materials and locally altering groundwater. As extraction could occur on up to 14,090 acres, the cumulative alteration over time would amount to about 40 percent of that occurring in alternative 1, and about 60 percent of that occurring in alternative 2A. Using the same assumptions on volume of water lost to the formation during the life of the project as were discussed in alternative 1, about 56,500 acre-feet of process water could be added to the local groundwater system. Groundwater gradients would, therefore, be steeper than normal, hastening the migration of groundwater from the immediate vicinity of the extraction zone. Transport of mobilized hydrocarbons and other minerals into previously unaffected areas could occur.

As discussed in alternative 2A, 25 gpm of concentrated wastewater would be injected to a suitable, but an as-yet, unidentified underground formation. Since water quality in candidate reinjection zones would initially be of poor quality, wastewater reinjection is not expected to have a major adverse effect.

Soils

The total amount of acreage available for development over the life of the project would be reduced from a maximum of 54,546 acres under alternative 1 to a maximum of 14,090 acres. The quantity of soil actually affected within the prospective areas would be 7,447 acres, 22,435 acres less than in alternative 1. The major benefit of this alternative is similar to alternative 2A, except that an additional 833 acres of Rizno soils would be protected by denying lease conversions within WSAs. For analytical purposes, it has been assumed that the maximum active disturbance at any one point in time would be 265 acres (reduced from 1,400 acres in alternative 1).

Overall soil loss from the project area would be reduced 25 percent from that expected under alternative 1, if other protective restrictions are applied, such as preventing operations on slopes greater than 33 percent (reducing developable acreage by 7,960 acres) and in areas where soils are particularly vulnerable to wind erosion once disturbed, reducing developable acreage by 205 acres (see table 50 for the total amount of soil disturbance by soil type).

If all the soil is removed to bedrock as proposed by the applicants and stockpiled within each prospective area, assuming an average soil depth of 1 foot and a bulking factor of 0.3, approximately 120,000 cubic yards of soil would be stockpiled onsite. Stockpiling of soils for long periods of time could adversely affect soil fertility and contribute to problems in reclamation and revegetation.

Damage to cryptogamic soil crusts by sulfur dioxide emissions would be lower in the lower intensity development scenario postulated for this alternative (under

the assumptions explained in the "Air Quality" section, sulfur dioxide emissions would be about one-sixth those experienced in alternative 1). However, amounts of sulfur dioxide sufficient to damage the lichens that form the crusts could still be emitted. It is not known just how this could affect the integrity of the crust or its soil-binding abilities, or how much additional soil loss would result from loss of the lichens.

Table 50: Disturbance by Soil Series

Soil Series	Acres Subject to Development	Net Acres Disturbed
Begay	463	185
Rizno (Channery)	1,371	548
Rizno (Warm)	1,591	636
Mellenthin	3,060	1,224
Arches	58	23
Travessilla	873	349
Mido	0	0
Farb	0	0
Otero	0	0
Badland	31	12
Total	7,447[1]	2,997[2]

[1]Acres of soil within prospective areas #1-#17, #22, and a portion of #23 only.
[2]Acres of soil significantly disturbed or removed by operations using a 40 percent disturbance factor.

Completion of each well would yield an average of 26 cubic yards of drill cuttings to the top of the White Rim, and an additional 2½ yards of cuttings from the White Rim. Each 308 wellfield would yield an estimated 8,800 cubic yards of cuttings. Cuttings from above the White Rim (an estimated 8,010 cubic yards per wellfield) would be similar in character to the native soils and be disposed of by spreading them out over the entire wellfield acreage (if the cuttings were evenly distributed in a 2-inch layer, they would cover approximately 30 acres), or by mixing them with the stockpiled soils. Cuttings from the White Rim (an estimated 790 cubic yards per wellfield) would probably contain hydrocarbon constituents that could inhibit soil fertility, and the cuttings could not be disposed of by spreading them over the soil surface. In all cases, the cuttings would decompose to a very fine particulate matter, and, if not properly disposed of and stabilized, would be susceptible to wind and water erosion.

All the soils within the lease unit are rated as either poor or very poor for reclamation potential (USDA, SCS 1981). Reclamation of the area would be possible but would require intensive efforts to ensure success. In addition, certain types of disturbances could present special reclamation problems--for example, boiler waste disposal areas.

Vegetation

Constructing the phase IV upgrading facilities would require removing all vegetation on the 40-acre site for the life of the project. As extraction zones move throughout the unit, 265 acres at any one time would be disturbed. Road upgrading and construction of ancillary facilities (such as the water supply pipeline and product pipelines) would also result in the destruction of approximately 600 additional acres of vegetation.

Under alternative 2B, total vegetation removed within the prospective areas (assuming that, on average, 40 percent of the vegetation would be removed as each area is developed) would be approximately 3,582 acres. Some disturbance of the remaining 5,373 acres within the prospective areas would also occur, but the exact type and amount of disturbance cannot be quantified at this time. Under this alternative, 15,925 acres of pinyon-juniper woodland (3,474 acres more than in alternative 2A) would be protected from surface-disturbing activity. The amount of vegetation disturbed at any one time would be reduced from 1,400 acres under alternative 1 to 265 acres. Table 51 shows anticipated disturbance by vegetation type throughout the developable portion of the project area.

Table 51: Disturbance by Vegetation Type

Vegetation Type	Acres Subject to Development	Net Acres Subject to Removal
Badlands woodland	11	4
Blackbrush shrubland	327	131
Pinyon-juniper shrub/woodland (blackbrush zone)	2,912	1,165
Pinyon-juniper shrub/woodland (sagebrush zone)	1,095	438
Pinyon-juniper woodland	3,777	1,511
Sagebrush shrubland	595	238
Slickrock woodland	98	39
Slope vegetation	140	56
Canyon riparian	0	0
Total	8,955[1]	3,582[2]

[1]Acres of vegetation type within prospective areas #1-#18, #22, and #23 only.

[2]Acres significantly disturbed or removed by operations assuming a 40 percent disturbance factor.

There are no known occurrences for threatened or endangered plant species within the lease unit, and surface-disturbing activities would not affect any such species. However, site-specific inventories would be required prior to

construction activities by the lessees, in accordance with the threatened and endangered species survey and consultation restrictions discussed in alternative 1.

Reclamation of disturbed areas would be difficult and require applying intensive measures over many growing seasons. Site preparation, irrigation, planting of potted shrubs and trees, seeding, and reseeding with native species, and fencing to exclude livestock and wildlife until vegetation could become established are all measures that would be necessary to ensure reclamation success.

Wildlife

In general, wildlife within BLM WSAs would receive more protection from direct adverse impact in this alternative than in alternatives 1, 2A, and 2C because no development could occur in the WSAs if leases are not converted in those areas.

Although extraction zones in Glen Canyon National Recreation Area and other BLM lands within the unit would not be completely denuded during phase IV activities, the presence of closely spaced wells and ancillary facilities would essentially destroy 265 acres of wildlife habitat. All vegetation would not be physically removed, so some small species, such as rodents, rabbits, and birds could probably manage to survive in reduced numbers in this degraded habitat.

The causes and nature of impacts on big game, nongame, raptors, and threatened and endangered species would be similar to those described for alternative 1, but the maximum amount of habitat directly disturbed would be reduced from 1,400 acres in alternative 1 to 265 acres, or 0.02 percent of the total habitat within the unit. Total habitat disturbance could be up to 14,090 acres (21 percent of the entire 66,040-acre lease unit originally proposed by the applicants).

Short-term effects on wildlife species would occur due to the sporadic nature of wellfield activities and to cyclical or seasonal wildlife use patterns. The restriction limiting activities within the zone of influence around active raptor nests (3,200 feet, or 1 km) during nesting season would mitigate adverse effects on raptors and would not be difficult to achieve. However, during operational stages of phase IV, a seasonal limit on activities within a nest's zone of influence could result in a complete shutdown of the applicants' activities.

As discussed in alternative 1, acute detrimental effects on wildlife could occur during spills or upset conditions, if amounts of harmful materials were released to the surrounding areas in sufficient concentrations and volumes to be life-threatening.

In alternative 2B, as in alternative 2A, reintroduction efforts designed to assist desert bighorn sheep populations in recovering from critically low levels would be at risk or would be totally infeasible for the duration of phase IV activities, particularly since transplant sites would be within Glen Canyon National Recreation Area, where most development would occur in this alternative.

Minor detrimental effects on deer and antelope within the lease unit could also occur. However, the proposed lease unit is not ideal antelope range, and development would not occur within the northwestern portions (where most suitable antelope range occurs) of the lease unit under this alternative, so minimal impacts on antelope are anticipated. A few individual antelope could be adversely affected by phase IV activities, including increased traffic on the roads into the lease unit, but any such adverse effects are not expected to affect the viability of the San Rafael herd in the vicinity of the federal lease unit. Individual deer could also be adversely affected. There are more deer within the unit than antelope, the numbers of deer that could be affected cannot be quantified. A portion of deer herd no. 29 could be displaced from the portion of the herd's range lying within the unit, but such displacement is not anticipated to have a major adverse effect on overall herd viability.

Water for steam generation and other onsite processing and domestic needs would be obtained from the Dirty Devil River, to the west of the lease unit at an estimated rate of 280 acre-feet annually. This quantity of water is only an estimated 0.5 percent of annual average flow, at certain times of the year, and some reaches of the Dirty Devil River are dry or very nearly dry. Further flow reductions in the Dirty Devil could adversely affect the viability of the razorback sucker, a fish proposed for listing as an endangered species (Clark, FWS, pers. comm. 1983). Insufficient information is available at this time on either the applicants' water withdrawal plans or on habitat for the razorback sucker, so no determination of effect on the razorback sucker can be made at this time. Complete surveys would be required when the applicants submit a complete, site-specific proposal for water withdrawal, and a determination would be made at that time whether section 7 consultation with the FWS for endangered species compliance would be required prior to any activity by the applicants.

The endangered humpback chub and Colorado squawfish, lower basin fish species, could also be threatened by water withdrawals from the Dirty Devil River sufficient to affect flows in the lower Colorado drainage, but, as such effects on the lower basin are not anticipated from this project, adverse effects on the humpback chub are not anticipated.

Air Quality

Air quality impacts in alternative 2B would not differ from those discussed in alternative 2A. Denying lease conversions within BLM WSAs and applying other protective restrictions would necessitate the relocation of the phase IV upgrading facilities, but until a new location is specifically identified, impact differences cannot be quantified.

Noise

Noise levels generated by phase IV in alternative 2B would be similar to those discussed in alternative 2A (see table 48 for a listing of noise levels generated during construction and operations).

Typical construction noise levels (47 dbA) calculated for a receptor at 1,000 feet are significantly above maximum background noise levels in rural areas. Adverse auditory effects on visitors and residents are not expected, but nonauditory effects (such a annoyance, aesthetic objections, and irritation) could occur.

Operation noise levels (58 dbA) calculated for a receptor at 1,000 feet are also significantly above maximum background noise levels. Levels high enough to cause adverse auditory effects on visitors and residents are not expected, and workers would be required to wear hearing protection. However, since operational noise would be 24 hours a day, nonauditory effects on residents and visitors could be enhanced. Nonauditory effects on wildlife (including avoidance, and disruption of feeding and breeding patterns) could also occur.

Since phase IV development would still require cyclical exhaustion and reconstruction of the wellfields over time, construction and operations would be carried on concurrently several times during the life of the project. Noise levels generated by concurrent construction and operations were not calculated but would be substantially higher than for either construction or operational noise alone.

Scenic Quality

In alternative 2B, 14,090 acres could ultimately be disturbed during the life of the project for modifications such as roads, wellfields, buildings, and pipelines. Leases within BLM WSAs would not be converted, and all modifications would take place on NPS-managed lands within Glen Canyon National Recreation Area and on non-WSA lands managed by the BLM. Short-range scenic quality impacts would be minimized within WSAs under this alternative, but project activities on adjoining lands would still be visible from the WSAs.

Scenic resource and public health and safety restrictions on lands within one-half mile of overlooks (1,685 acres) and on approximately 795 acres of land with the highest visual exposure from the major overlooks would reduce the impacts on scenic quality but would not eliminate them entirely. Scenic quality impacts could be mitigated totally only if all operations on the mesa tops above the Orange Cliffs were precluded. Impacts on viewsheds from Canyonlands into the project area would be reduced by limiting activity on 2,455 acres within a scenic buffer area along the Orange cliffs, which would minimize adverse impact on long-range views from the park.

Under this alternative, BLM lands affected by operations within VRM class II would be reduced to 274 acres, 5,315 acres less than in alternative 1. Lands affected within VRM classes III and IV would be reduced to 1,126 and 1,491 acres, respectively.

The 200-foot buffer along the Flint Trail would provide little visual screening, given the terrain type and relatively sparse and low-profile vegetative cover within the proposed federal lease unit. The limited spatial separation does temper the impact somewhat for recreationists traveling the road. The upgrading plant could not, under this alternative, be located where proposed by the applicants. If a new location is chosen that conforms with restrictions

relating to reduction of scenic resource impacts, such impacts could be minimized. However, given the size of the facilities and the terrain characteristics within the unit, complete screening likely would not be possible.

IMPACTS ON CULTURAL RESOURCES

Historic Resources

In alternative 2B, applying the no-surface-occupancy restrictions to 5,065 acres to protect the most sensitive of archeological and historic resources would preclude development in the proposed Flint Flat/South Fork Happy Canyon district where the only known historical resource (the Wolverton Cabin) is located. No direct adverse impacts on that resource are anticipated.

Indirect impacts due to increased numbers of people in the area, such as those due to wear-and-tear and vandalism, would still occur. There would be fewer of the applicants' employees within the proposed federal lease unit, but the increase in numbers of visitors to the area due to road upgrading would likely be of similar magnitude to those discussed in alternative 1. However, as historic resources are a relatively minor resource aspect of the proposed federal lease unit, major adverse effects are not anticipated.

Archeological Resources

As for alternative 1, full production under phase IV could have a major detrimental effect on the area's archeological remains. Development would be precluded on 5,065 acres containing concentrations of the most sensitive known archeological resources proposed for inclusion in the National Register property, and on an additional 20,091 acres of WSA lands within the unit, the type and intensity of development (even at a substantially lower production rate) would be incompatible with the goals of site protection, preservation, and interpretation.

Applying restrictions designed specifically to reduce impact on cultural resources, plus other restrictions that have the practical effect of reducing or preventing surface disturbance, would also reduce direct impacts to archeological resources. However, up to 14,090 acres could ultimately be disturbed for tar sand development activities. As the site density within the proposed federal lease unit has been estimated at a minimum of 24 sites per square mile, at least 530 sites could be directly affected. Much of the land that could be developed under this alternative is within Glen Canyon National Recreation Area, where the estimated site density is 34 sites per square mile. Therefore, the number of sites that could be disturbed may be much higher. As in alternative 1, 38 known archeological site would be affected if the Flint Trail is upgraded.

Prior to initiation of any ground-disturbing activity, a 100 percent archeological survey would be required. All sites located during the survey would be evaluated for their contribution to the Orange Cliffs Multi-Resource National

Register property, and all mitigation would be carried out in accordance with the approved cultural resources mitigation plan (as discussed in alternative 1).

As air pollutant emissions are expected to be lower under this alternative than for alternative 1, adverse effects on the area's rock art due to stone deterioration, pigment alterations, and staining or darkening would also be reduced. The probability of damage due to air pollutants cannot be quantified at this time but would be relatively minor.

Damage to or destruction of individual sites could be reduced by applying appropriate mitigation measures (including avoidance, mapping, collecting, testing, or excavating). The intrusion on and loss of in-context data for the proposed Orange Cliffs Multi-Resource National Register property cannot be mitigated. Over time, in-context archeological remains would be eliminated within the 14,090-acre area that could ultimately be developed under this alternative.

IMPACTS ON SOCIOECONOMIC ENVIRONMENT

The impacts of phases I, II, III, and IV on the socioeconomic environment would be similar to those discussed in alternative 2A, except as specifically noted below. Major differences between socioeconomic consequences generated in this alternative and those generated in alternative 2A are in the following areas.

Grazing and Livestock Production

Most of the grazing use within the proposed federal lease unit is on the Robbers' Roost allotment, and a large portion of that allotment within the unit is also within the French Spring/Happy Canyon WSA. Denying lease conversions within WSAs would preclude development in areas of heaviest grazing use and would therefore minimize impacts. Minimal impacts on grazing use within the Sewing Machine allotment would still occur, particularly if livestock were precluded from use of any water sources because of operational activities.

NPS and BLM Operations

The phase III and IV activities planned for the Gordon Flats area (the initial most intensive development) could not take place on BLM-managed lands under this alternative; impacts on BLM operations would decrease and impacts on NPS operations would increase. During phase III, the NPS operational effort would be expected to be three times higher than present levels and would require the addition of at least one more person stationed at Hans Flat. At phase IV, an estimated six additional persons would be required for NPS staff at Hans Flat ranger station. An increase in NPS structural facilities in the Orange Cliffs area (either at Hans Flat or at another appropriate location) would also be needed.

IMPACTS ON LAND USE

In alternative 2B, denying lease conversions within WSAs would not be in conformance with current BLM land use plans. The areas are open to leasing with standard stipulations (category 1). However, as noted in alternative 2A, management framework plans for the area may be amended through the NEPA process. A decision by BLM to implement this alternative would be a decision to alter the existing land use planning decisions.

The scale, scope, and duration of phases III and IV would conflict with NPS objectives of protecting scenic, scientific, and historic values contributing to the public enjoyment of NPS-administered lands. In alternative 2B, this effect could be enhanced because more development would occur on NPS lands. Denying conversion within BLM-managed WSAs but allowing conversion within Glen Canyon would not be in conformance with NPS land use plans and management objectives.

IMPACTS ON RECREATION AND WILDERNESS VALUES

In alternative 2B, the recreational values in BLM WSAs would receive the maximum amount of protection from direct effects. However, a large portion of the development would occur on NRA lands, and phase IV activities would still conflict with NPS management objectives for the Orange Cliffs area within Glen Canyon (USDI, NPS 1977), as well as legislative objectives for the Horseshoe Canyon and Maze areas within Canyonlands (Sen. Rept. 92-156, 1971). Present management objectives would be unattainable for a long period of time (the life of the commercial operations), and perhaps for many years more, as the area is of a type that is typically slow to recover from man-caused disruptions.

Denying lease conversions within WSAs would protect the WSAs from any direct impacts due to operations. However, spillover effects due to noise, air pollution, etc., could still occur within the WSAs if development occurs on adjacent BLM and NPS lands.

ALTERNATIVE 2C: DENY CONVERSION ON NPS NRA LANDS

Alternative 2C also assumes a 5,000-bpd production rate and applies the general restrictions (see appendix C), plus additional protective restrictions for sensitive resources (see table 4 and figures 9-18). In addition, 23 leases or portions of leases within Glen Canyon National Recreation Area would not be converted (see table 6).

Phases I and II would generate impacts not substantially different from those discussed in alternative 1. Under alternative 2C, the two phase I coreholes and eight of the phase II coreholes would require location adjustments, and four of the coreholes within the BLM WSAs would be subject to the nonimpairment management standard. The remaining phase II coreholes would also require location adjustments to conform with protective restrictions. If new corehole locations and access routes are chosen that are in conformance with the standard and additional protective restrictions, the impacts of phases I and II would be minimal.

Phase III and IV activities could not be located within NRA lands, or in WSAs as long as the nonimpairment management standard is in effect. Wherever located, the phase III facilities would generate impacts similar to those discussed in alternative 1, except as specifically identified. Phase IV activities analyzed under alternative 2C would apply the same technology as described in the plan of operations (see appendix A), but would be reduced both in area of application and in rate of production. All restrictions would be applied. The reduction in impacts after applying the protective restrictions is discussed, as are any residual unmitigated impacts, for each of the natural, cultural, and socioeconomic resources.

IMPACTS ON NATURAL RESOURCES

Geologic Resources

Phase IV activities under alternative 2C could alter the chemical and structural characteristics of the tar sand host (the White Rim sandstone) underlying approximately 14,745 acres (8,971 acres within the extraction zones) of the proposed federal lease unit. The changes would be similar to those described in alternative 1. Applying the additional protective restrictions to prevent extraction activities within 500 feet of cliff edges, which would eliminate 3,655 acres from development under this alternative, would minimize the possibility of subsidence-related rockfalls or steam "blowouts" on cliff faces. Geologic changes would have secondary effects on groundwater, as discussed in the "Water Resources" section.

Topographic Resources

As discussed in alternative 1, constructing wellfields and upgrading facilities and associated activities, such as road building, would alter the topographic

features. However, denying lease conversions within NRA lands would ensure that such changes would not occur on 23,336 acres of NPS-administered lands within the 54,546 acres eligible for conversion within the proposed federal lease unit. Protective restrictions preventing operations on slopes greater than 33 percent (applied to 8,180 acres) would minimize the amount of topographic disturbance from the large cuts-and-fills that would be necessary for construction is such areas.

The maximum amount of active topographic disturbance at any one time would be reduced from approximately 1,400 acres required under alternative 1 to 265 acres. Over the life of the project, up to 14,745 acres could be modified by mounded roadfills, ditches, leveling for wellpads and pipelines, stockpile and material sites, solid waste disposal sites, and filled and leveled areas for construction of ancillary facilities. Small quarrying operations for gravel and other construction, road, and pad material could be necessary in the vicinity of the lease unit. Although the applicants would be required to reclaim such area, the original topographic contours could not be restored.

Paleontological Resources

Under alternative 2C, paleontological resources on NRA lands would be protected from direct impacts; however, because the extraction areas could, during phase IV, extend into areas on BLM lands where paleontological resources are known to occur, direct impacts could still occur in those areas. A reduction in the number of people in the area (due to restrictions that would reduce employment and duration of the project) could cause an unquantifiable reduction in secondary adverse effects such as increased collection or vandalism. Secondary adverse effects caused by upgrading access roads into the area would remain at a level similar to that discussed in alternative 1. Although both direct and secondary impacts on paleontological resources would still probably occur under this alternative, these resources are currently not a major known resource aspect with the proposed federal lease unit, so such effects would be relatively minor.

Energy and Minerals

Under the assumptions described in alternative 1, impacts on the present energy and minerals environment would occur during phase IV. Overall, the energy efficiency would remain at about 44.5 percent, but the area of production would be reduced to a maximum areal extent of 14,745 acres. The relative amounts of resource extracted and left in the ground cannot be quantified, since the extent of the resource and the amount that could be extracted is unknown. The extracted and upgraded bitumen would be marketed as syncrude, which would contribute petroleum products available from U.S. sources. The production rate would be the same in this alternative as for 2A and 2B, but the duration of operations could differ.

As discussed in alternative 1, recovery of uranium resources would be precluded in areas where tar sand is being actively extracted. The areal extent precluded at any one time would be reduced from 1,400 acres to 265 acres. Any

subsequent underground mining of uranium ore could require the use of larger pillars; thus, a portion of any uranium ores present could not be recoverable as a result of tar sand extraction activity. The exact loss cannot be quantified, but is not expected to be major.

Water Resources

Surface disturbances associated with the progressive phase IV development could result in increased runoff and erosion. Applying the restrictions to protect surface recharge areas for wells, springs, and seeps would eliminate 2,310 acres from development and would minimize adverse effects on surface recharge areas for these water sources. Applying standard requirements for erosion control, watercourse protection, and design of nonoverflowing storage and surge ponds would minimize the possibility of spills and consequent degradation of surface waters. Accidental spills of hydrocarbons and other process-related substances could still occur, but no facility can ever be engineered so that there is absolute certainty of no spilling or failures; therefore, a slight possibility of surface water degradation would still exist.

Constructing a water supply pipeline in Happy Canyon or in one of the other major drainages to the Dirty Devil River would contribute to sediment load to and within the river during construction and if there are any breaks during the operational life of the pipeline.

As discussed in alternative 2A, a lower production rate would reduce makeup water requirements (175 gpm for 5,000 bpd of production, or an annual projected water use of 280 acre-feet). Assuming a 50-year project life for comparative purposes, 14,000 acre-feet of water would be required, as would disposal of 500,000 cubic yards of silt. Under this alternative, silt disposal would not occur within NRA lands, and attendant revegetation and erosion problems likewise would not occur. Impacts on BLM-managed lands due to erosion of silt and consequent damage to water sources would remain a problem for BLM land managers.

Theoretical reductions in salinity in the Colorado River system would be as discussed in alternative 2A (560 to 760 tons of salt removed annually, with a theoretical annual benefit to downstream users of $30,000 to $39,000 per year). Since this is well within the uncertainty limits of the calculation method used, no firm conclusions can be drawn on whether a real benefit would accrue.

Downward water leakage from upper to lower formations could occur particularly during construction of phase IV wellfields. During phase IV, assuming a downward leakage rate of 1 gpm per well, approximately 490,000 gpd of downward leakage would occur as long as the connection between aquifers remains open. Depleting the upper zones could adversely affect existing springs and seeps on or near mesa tops. Applying protective restrictions to prevent development near springs, wells, and seeps could minimize this impact, but it cannot be stated with certainty that adverse effects on flows would not occur. Springs and seeps on BLM-managed lands on the west side of the Big Ridge would be most affected.

The one-half-mile radius protective buffer around springs, seeps, and wells would also minimize the possibility that uncontrolled steam excursions or undesirable fracturing could adversely affect flows. Applying the restriction on development within the one-half-mile radius of the Hans Flat ranger station would also minimize the possibility of adverse effects on the quantity or quality of the water in the NPS well at the ranger station.

As discussed in alternative 2A, steam injection would hydrothermally alter the arkosic sandstone matrix of the White Rim, mobilizing materials and locally altering groundwater. As extraction could occur on up to 14,745 acres under this alternative, the cumulative alteration over the life of the project would amount to about 40 percent of that occurring in alternative 1, and 60 percent of that occurring in alternative 2A. Using the same assumptions on volume of water lost to the formation, about 60,000 acre-feet of process water could be added to the local groundwater system. Groundwater gradients would, therefore, be steeper than normal in the project area, hastening the migration of groundwater from the immediate vicinity of the extraction zone. Transporting mobilized hydrocarbons and other minerals into previously unaffected areas could occur.

As discussed in alternative 2A, 25 gpm of concentrated wastewater would be injected to a suitable, but as-yet unidentified, underground formation. As water quality in candidate reinjection zones would initially be of poor quality, wastewater reinjection is not expected to have a major adverse effect.

Soils

Under the lower intensity development scenario postulated in alternative 2C and denying lease conversions on NRA lands, the total amount of surface disturbance over the life of the project would be reduced from a maximum of 54,546 acres in alternative 1 to a maximum of 14,745 acres under alternative 2C. The quantity of soils within the extraction zones that would be subject to disturbance would be 7,523 acres, 22,359 acres less than in alternative 1. By not converting leases within NRA lands, almost all the Rizno (Channery) soils would be avoided, which would reduce the potential of water erosion on these highly susceptible soils.

Overall, the potential soil loss from the project area could be reduced by 75 percent from that expected under alternative 1 by not converting on NRA lands and applying the protective restrictions for sensitive resources on the remaining acreage (see table 4).

The total amount of potential soil disturbance by soil type under alternative 2C is presented in table 52.

Table 52: Disturbance by Soil Series

Soil Series	Acres Subject to Development	Net Acres Disturbed
Begay	1,000	400
Rizno (Channery)	1,457	583
Rizno (Warm)	219	88
Mellenthin	3,462	1,385
Arches	1,174	470
Travessilla	211	85
Mido	0	0
Farb	0	0
Otero	0	0
Badland	0	0
Total	7,523[1]	3,011[2]

[1]Acres of soil within prospective areas #1-#17, #22, and a portion of #23 only.
[2]Acres of soil significantly disturbed or removed by operations using a 40 percent disturbance factor.

If all the soil is removed to bedrock, as proposed by the applicants, wherever soil disturbance is necessary within each extraction zone and stockpiled, assuming an average soil depth of 1 foot and a bulking factor of 0.3, approximately 120,000 cubic yards of soil would be stockpiled onsite for each extraction zone. Assuming a stockpile height of 25 feet, approximately 3 acres of storage space would be required to stockpile the soil within each extraction zone. As discussed in alternative 1, stockpiling of soils for long periods of time could adversely affect soil fertility.

Damage to cryptogamic crusts by sulfur dioxide emissions would be lower under the lower intensity scenario postulated for this alternative. However, amounts of sulfur dioxide sufficient to damage the lichens that form the crusts could still be emitted. It is not known just how this would affect the integrity of the crust or its soil-binding abilities, or how much additional soil loss would result from loss of the lichens.

Completion of each of the wells, even under a reduced production scenario, would yield an average of 26 cubic yards of drill cuttings to the top of the White Rim sandstone, and an additional 2½ yards of cuttings from the White Rim. Each wellfield drilled would yield an estimated 8,800 cubic yards of cuttings. Disposing of that volume of cuttings in pits, as proposed by the applicants, would be difficult due to the shallowness of the soil cover in many parts of the lease unit. The estimated 8,010 yards of cuttings from above the White Rim could be disposed of by spreading them out over the entire wellfield acreage (if the cuttings were evenly distributed in a 2-inch layer, they would cover approximately 30 acres) or by mixing them with the stockpiled soils. Cuttings from the White Rim (an estimated 790 cubic yards per wellfield) would likely

contain hydrocarbon constituents that could inhibit soil fertility and, therefore, could not be disposed of by spreading over the soil surface. In all cases, the cuttings would decompose to very fine particulate matter, and, if not properly disposed of and stabilized, would be very susceptible to wind and water erosion.

As discussed in alternative 2A, all the soils within the proposed federal lease unit are rated as either poor or very poor for reclamation potential (USDA, SCS 1981). Reclamation of the area would be possible but would require intensive efforts to ensure success. In addition, certain types of disturbances could present special reclamation problems.

Vegetation

As discussed in alternative 2A, constructing the phase IV facilities would require removing all vegetation on the 40-acre site for the life of the project and removing vegetation (total removal estimated at 40 percent) on each of the extraction zones in 265-acre increments. Under alternative 2C, total vegetation removed within the extraction zones would be 3,435 acres (see table 53), including, eventually, areas within WSAs if the nonimpairment standard is removed due to Congressional action on wilderness status. The remaining 5,155 acres within the extraction zones would also experience disturbance but most likely would not have to be removed entirely. Road upgrading and construction of ancillary facilities (such as the water supply pipeline and product pipelines) could also result in the destruction of up to 600 additional acres of vegetation.

Table 53: Disturbance by Vegetation Type

Vegetation Type	Acres Subject to Development	Net Acres Subject to Removal
Badlands woodland	273	109
Blackbrush shrubland	169	68
Pinyon-juniper shrub/ woodland (blackbrush zone)	1,471	588
Pinyon-juniper shrub/ woodland (sagebrush zone)	1,276	510
Pinyon-juniper woodland	3,988	1,595
Sagebrush shrubland	1,009	404
Slickrock woodland	293	117
Slope vegetation	111	44
Canyon riparian	0	0
Total	8,590[1]	3,435[2]

Note: Figures used are estimates only due to uncertainty of site locations.

[1]Acres of vegetation type within prospective areas #1-#17, #22, and a portion of #23 only.

[2]Acres significantly disturbed or removed by operations assuming a 40 percent disturbance factor.

As previously discussed, reclamation of disturbed areas may be possible but would require intensive measures over many growing seasons. Irrigation, planting of potted shrubs, seeding and reseeding with native species, site preparation, and fencing to exclude livestock and wildlife until vegetation can become established would be necessary to ensure reclamation success. If proper techniques are used, it is estimated that shrub areas can be restored to mature status within 5 years after cessation of operations, and pinyon-juniper woodland areas can be restored to mature stands 60-70 years after the trees become established.

Because no federally listed or proposed threatened or endangered plant species or their habitats are known to exist within the proposed federal lease unit, adverse effects on the one listed and four proposed plant species found in southeastern Utah are not anticipated. However, prior to any surface-disturbing activities, the lessee would be required to perform site-specific surveys for threatened or endangered plant species. If such species are encountered, consultation would be required as discussed in alternative 1.

Wildlife

In general, wildlife within Glen Canyon would receive more protection from direct adverse impacts under this alternative than from alternatives 1, 2A, and 2B because no development would occur on NRA lands if leases are not converted in those areas.

Extraction zones on BLM lands within the unit would not be completely denuded during phase IV activities, and essentially 265 acres at any one time would be destroyed as wildlife habitat. All vegetation would not be removed, so some small species, such as rodents, rabbits, and birds, could probably manage to survive in reduced numbers in this degraded habitat.

The causes and nature of impacts on big game, nongame, raptors, and threatened and endangered species would be similar to those described in alternative 2A.

Short-term effects on wildlife species would occur due to the sporadic nature of wellfield activities and to cyclical or seasonal wildlife use patterns. The restriction limiting activities around active raptor nests (3,200 feet, or 1 km) during nesting season would mitigate adverse effects on raptors and would not be difficult to achieve. However, during operational stages of phase IV, a seasonal limit on activities could result in a complete shutdown of the applicants' activities for up to four months each year.

Acute detrimental effects on wildlife could occur during spills or upset conditions, if amounts of harmful materials were released to the surrounding areas in sufficient concentrations and volumes to be life-threatening.

In alternative 2C, effects on bighorn reintroduction efforts in Glen Canyon and Canyonlands would be reduced. Since bighorn sheep appear to be extremely sensitive to human intrusion (including increased traffic and noise) related to development on neighboring BLM lands could still adversely affect this species.

Minor detrimental effects on deer and antelope within the lease unit could also occur. A few individual antelope could be adversely affected by phase IV activities, including increased traffic on the roads into the unit, but any such adverse impacts are not expected to affect the viability of the San Rafael herd in the vicinity of the unit. Individual deer could also be adversely affected. A portion of deer herd no. 29 could be displaced from the portion of the herd's range lying within the unit, but such displacement is not anticipated to have a major adverse effect on overall herd viability.

Water for steam generation and other onsite processing and domestic needs would be obtained from the Dirty Devil River, to the west of the proposed unit, at an estimated rate of 280 acre-feet annually. This quantity of water is only an estimated 0.5 percent of annual average flow, at certain times of the year, some reaches of the Dirty Devil River are dry or nearly dry. Further flow reductions in the Dirty Devil could adversely affect the viability of the razorback sucker, a fish proposed for listing as an endangered species (Clark, FWS, pers. comm. 1983). Insufficient information is available at this time on either the applicants' water withdrawal plans or on habitat for the razorback sucker, so no determination of effect on the razorback sucker can be made at this time. A complete survey would be required when the applicants submit a complete site-specific proposal for water withdrawal, and a determination would be made at that time whether section 7 consultation with the FWS for endangered species compliance would be required prior to any activity by the applicants.

The endangered humpback chub and Colorado squawfish, lower basin fish species, could also be threatened by water withdrawals from the Dirty Devil River sufficient to affect flows in the lower Colorado drainage, but, as such effects on the lower basin are not anticipated form this project, adverse effects on the humpback chub are not anticipated.

Air Quality

Air quality impacts under alternative 2C would not differ from those discussed in alternative 2A. Denying lease conversions within NRA lands, applying the nonimpairment standard within BLM WSAs, and applying other protective restrictions could necessitate the relocation of the phase IV upgrading facilities, but until a new location is specifically identified, impact differences cannot be quantified.

Noise

Noise levels generated by phase IV activities under alternative 2C would be similar to those discussed in alternative 2A for the area affected by development (see table 48 for a listing of noise levels generated during construction and operations).

Typical construction noise levels (47 dbA) calculated for a receptor at 1,000 feet are significantly above maximum background noise levels for rural areas (16 to 35 dbA). Adverse auditory effects on visitors and residents are not

expected, but nonauditory effects (such as annoyance, aesthetic objections, and irritation) are likely to occur in the vicinity of the construction activities.

Operational noise levels (58 dbA) calculated for a receptor at 1,000 feet are also significantly above maximum background levels. Levels high enough to cause adverse auditory effects on visitors and residents are not expected, and workers would be required to wear hearing protection. However, since operational noise would be continuous over 24 hours per day, nonauditory effects on residents and visitors are likely to be enhanced. Nonauditory effects on wildlife (including avoidance and disruption of feeding and breeding patterns) would also likely occur.

Such adverse impacts would be reduced in NRA lands and in the western portions of Canyonlands National Park due to the absence of development activities within the recreation area under this alternative.

However, as noise impacts do not respect geographic boundaries, construction and operation activities on BLM lands could still have adverse nonauditory effects on visitors to Glen Canyon and Canyonlands. Applying the 1-mile radius no-development buffer around the Hans Flat ranger station would provide some distance attenuation and reduce nonauditory effects for the residents of the ranger station, but the potential for such adverse nonauditory effects would not be reduced to zero by this or other restrictions tending to increase attenuation distance.

Since phase IV development would still require cyclical exhaustion and reconstruction of wellfields over time, construction and operations would be carried on concurrently several times during the life of the project. Noise levels generated by concurrent construction and operations were not calculated, but would be substantially higher than for either construction or operational noise alone.

Scenic Quality

Under alternative 2C, up to 14,745 acres within the unit could be modified during the life of the project.

Denying lease conversion within NRA lands would protect the scenic resource values on 23,336 acres, significantly reducing the impacts on short-range views from Glen Canyon to other points within the recreation area. In addition, long-range views from Canyonlands to the Orange Cliffs area within Glen Canyon would be protected. Impacts on scenic views from Glen Canyon into BLM lands would be reduced in the short run by applying the nonimpairment standard for the WSAs. However, if Congress acts to remove the WSAs from consideration for wilderness designation, these lands could also be developed. Depending upon exact siting, such development would be visible from many points within Glen Canyon, particularly from the overlook points along the Flint Trail. However, applying the protective restriction on the overlook viewsheds would reduce this impact by 1,575 acres (see table 4). If not properly mitigated on the remaining areas, these impacts could contribute to the degradation of the recreational values of the recreation area.

IMPACTS ON CULTURAL RESOURCES

Historic Resources

Under alternative 2C, denying lease conversions within Glen Canyon would preclude development in the Flint Flat/Flint Seep area where the only known historic-period resource (the Wolverton cabin) is located. No direct adverse impacts on that resource are anticipated. Indirect impacts due to increased numbers of people in the area, such as wear-and-tear and vandalism, would still occur. There would be fewer of the applicants' employees in the area, but the increase in numbers of visitors due to the road upgrading would be of similar magnitude to those discussed in alternative 1. However, as historic-period resources are a relatively minor resource aspect of the proposed federal lease unit, major adverse effects are not anticipated.

Archeological Resources

Up to 14,745 acres could ultimately be disturbed for tar sand development activities under this alternative. As the site density within the proposed federal lease unit has been estimated at 24 sites per square mile, at least 545 sites could be directly affected. Under this alternative, the cultural resources of Glen Canyon would receive greater protection from direct impacts than under alternatives 2A and 2B.

Prior to initiation of any ground-disturbing activity, a 100 percent archeological survey would be required. All sites located during the survey would be evaluated for their contribution to the Orange Cliffs Multi-Resource property, and all mitigation would be carried out in accordance with the approved area-wide cultural resources mitigation plan (as discussed in alternative 1).

Air pollutant emissions are expected to be lower under this alternative than for alternative 1, and adverse effects on the area's rock art due to stone deterioration, pigment alterations, and staining or darkening would also be reduced. The probability of damage due to air pollutants cannot be quantified at this time, but would be relatively low.

Although damage to or destruction of individual sites can be reduced by applying appropriate mitigation measures (including avoidance, mapping, collecting, testing, or excavating), the intrusion on and loss of in-context data for the proposed Orange Cliffs Multi-Resource National Register property would not be mitigated entirely. Over time, a large portion of the in-context archeological remains within the 14,745-acre area that could be developed under this alternative would be eliminated.

IMPACTS ON SOCIOECONOMIC RESOURCES

The impacts of phases I, II, III, and IV on the socioeconomic environment would be similar to those discussed in alternative 2A except as specifically noted

below. Major differences between socioeconomic consequences generated under this alternative and those generated under alternative 2A are in the following areas.

Grazing and Livestock Production

Denying lease conversions within Glen Canyon would preclude development in portions of the Robbers' Roost, Flint Trail, and Sewing Machine allotments, and applying the nonimpairment standard to the WSAs would further preclude intense development in the BLM WSAs. Impacts on grazing use would be minimized under alternative 2C. If the nonimpairment standard for WSAs is no longer in effect after Congressional action, minor impacts due to conflicts between development and grazing could occur, mostly within the Robbers' Roost allotment.

NPS and BLM Operations

Since phase III and IV activities planned for the Gordon Flats area could not take place on NPS-managed lands under this alternative, impacts on NPS operations would be minimized and those on BLM operations would be enhanced. However, if access is required on the Flint Trail, NPS operational impacts due to increased traffic and visitor-operator road use conflicts would be greater. The NPS anticipates that at least one additional person stationed at Hans Flat would be required during phases III and IV to handle these concerns.

IMPACTS ON LAND USE

Under alternative 2C, lease conversions with additional protective restrictions would not be in conformance with present BLM land use plans because the areas are open to leasing with standard stipulations (category 1). However, as noted in alternative 2A, management framework plans for the area could be amended throughout the NEPA process. A decision by BLM to implement this alternative would be a decision to alter the existing land use planning decisions.

Under alternative 2C, denying lease conversions within Glen Canyon would be in conformance with present NPS land use plans. Areas within the recreation and resource utilization (RRU) zone within Glen Canyon are open for leasing (including lease conversion) only if the development activities likely to result from lease conversion are compatible with public enjoyment of the area for recreational purposes. Denying leases would be in conformance with NPS management objectives of protecting scenic, scientific, and historic values contributing to the public enjoyment of NRA lands.

IMPACTS ON RECREATION AND WILDERNESS VALUES

Under alternative 2C, the recreational values in Glen Canyon would receive protection from most direct effects. However, if development occurs on

adjacent BLM lands, indirect effects on recreational use of the Orange Cliffs area and of the Maze district in Canyonlands would still occur. Such effects would include spillover environmental effects that do not respect geographic boundaries (such as air pollution and noise) from development on BLM lands. Present NPS management objectives for both the Maze district within Canyonlands and the Orange Cliffs area within Glen Canyon would therefore be affected for the duration of commercial-scale operations.

Recreational use within the BLM WSAs would remain essentially unchanged from the existing use of primitive and unconfined recreation as long as the nonimpairment standard remains in effect. Recreational use on other BLM lands would probably be precluded, at least in the areas where active tar sand operations are occurring, for the duration of the operations. If the nonimpairment standard is no longer in effect in the WSAs, recreational use within the WSAs would also be precluded during active tar sand operations, and the character of any recreational use would change.

Denying lease conversions within Glen Canyon would have no direct effect on wilderness values of the BLM WSAs. The nonimpairment management standard would be applied to the WSAs until Congress acts either to designate these areas as wilderness (no development could occur) or to drop them from consideration as wilderness (full development, subject to other protective restrictions applied to protect sensitive resources). In the later instance, a Congressional determination would be made that the areas do not possess wilderness values, so no impact on wilderness values could occur.

Denying lease conversions within NRA lands would provide additional protection for recommended wilderness on NPS lands in the vicinity of the proposed federal lease unit (including the Maze district and Horseshoe Canyon detached unit, Canyonlands, and the area east of the Orange Cliffs in Glen Canyon) by providing additional separation and insulation from spillover effects from development on BLM lands.

ALTERNATIVES 2A, 2B, and 2C - UNAVOIDABLE ADVERSE IMPACTS

Implementing the required federal mitigation measures (see appendix C) and the additional protective measures (see table 4) and denying conversion in selected areas within WSAs for alternative 2B and within Glen Canyon for alternative 2C would reduce impacts of the project as proposed. Those impacts that would remain following mitigation are described below. If impacts are eliminated by applying the measures, discussion is omitted.

Topographic Resources

Constructing a major industrial facility and development of up to 18 prospective areas (up to an estimated total of 5,500 wells over the life of the project), ancillary facilities, such as roads and pipelines, and solid waste disposal would constitute major topographic alterations within the proposed federal lease unit. For alternative 2A, up to 23,541 acres would be disturbed; for alternative 2B, up to 14,090 acres; and for alternative 2C, up to 14,457 acres would be disturbed over the life of the project, in 265-acre increments. Under alternatives 2A and 2C, these disturbances could not occur within the BLM WSAs unless Congress acts to remove the areas from consideration for wilderness designation; if that occurs, the former WSAs could be fully developed subject to standard and additional protective restrictions. Under alternative 2B, no development could occur on BLM WSAs, so topographic alterations would occur only on non-WSA BLM lands and within Glen Canyon. Under alternative 2C, lease conversions would be denied within Glen Canyon, so major topographic disturbances would not occur within NRA boundaries, except as related to access or transportation corridors. Under alternatives 2A, 2B, and 2C, topographic disturbances would be unavoidable and constitute major alterations of the existing landscape character and form.

Water Resources

Water requirements would be 280 acre-feet per year, or about 0.5 percent of the annual flow of the Dirty Devil River; this water would not be available for other uses. The area of the lease unit is arid and lack of available water is a major limiting factor for both human and wildlife use, so competing uses that require water, such as irrigation, community water requirements, and other energy development projects, would be foreclosed. The annual water requirements are projected to be the same under alternatives 2A, 2B, and 2C.

Development could dewater springs and seeps in the vicinity of the lease unit, but activities within the surface recharge zones for springs and seeps would be minimized. The proposed mitigation cannot absolutely ensure that no effects would occur. As there are few alternatives available for water sources, any diminution of flows or degradation of water quality would have a significant adverse effect on both humans and animals that depend upon water sources in the area.

Under alternative 2A, these effects could occur for water sources within BLM WSAs, on other BLM lands, and on NRA lands. If, under alternative 2B, leases within BLM WSAs are not converted and tar sand development in those areas is foreclosed, development would not occur in a portion of the Happy Canyon drainage where there are a number of springs and seeps, so the possibility of unavoidable adverse effects on those water sources would be diminished. Under alternative 2C, if leases within Glen Canyon are not converted, the possibility of major direct effects on springs and seeps in the eastern portion of the proposed federal lease unit would be diminished.

Soils

Approximately 5,215 acres of soils would be totally disturbed during the life of the project under alternative 2A, 2,980 acres under alternative 2B, and 3,030 acres under alternative 2C. Soils in the area are highly erodible and difficult to stabilize and reclaim. The applicants would be required to reclaim areas, but reclamation would be difficult and take a much longer time than under more favorable circumstances. The potential for soil loss and erosion, even if reclamation is successful, is significant.

Vegetation

The applicants would be required to reclaim areas once operations are completed, but reclamation would be slow and difficult. The amount of vegetation removed would be reduced significantly from that proposed under alternative 1 (5,902 acres, 3,582 acres, and 3,436 acres, respectively, for alternatives 2A, 2B, and 2C).

Grassland and shrubland could be reclaimed to its former (pre-operations) state within 5 years if intensive reclamation techniques are applied. Under alternative 2A, the 81 percent of the developable area covered by mature pinyon-juniper vegetation types could not be restored to mature stands for up to 70 years after operations cease. Under alternative 2B, 87 percent and under alternative 2C, 78 percent of the developable area is covered by mature pinyon-juniper. For areas within Glen Canyon that would be affected under alternatives 2A and 2B, the removal of the pinyon-juniper vegetative associations would adversely affect the best example of mature pinyon-juniper woodlands existing within the recreation area.

Wildlife

Up to 5,902 acres (under alternative 2A), 3,582 acres (under alternative 2B) and 3,436 acres (under alternative 2C) of wildlife habitat would be directly disturbed (in 265-acre increments) over the life of the project. An additional unknown quantity of wildlife habitat would be altered by effects such as noise, traffic, increased human intrusion, and elimination of or exclusion from water sources. Under alternatives 2A, 2B, and 2C, planned reintroduction of desert bighorn sheep into the area could not be accomplished during the life of the

project, and adverse impacts on existing bighorn populations (including exclusion from the lease unit and its vicinity) would occur. Under alternative 2C, adverse direct impacts on the expansion of the Canyonlands herd into the recreation area would be minimized. Similar impacts (both direct and secondary) on other large species and raptors are expected, and although required and additional proposed mitigation would reduce these impacts, the combined effects of project activities on wildlife and habitat would be significant and unavoidable.

Air Quality

The applicants would have to meet regulatory air pollution control requirements to receive any permits, and the projected emission rates from 5,000-bpd production for alternatives 2A, 2B, and 2C would result in exceedances of the class II PSD increment for particulate matter for Glen Canyon, and the class I PSD increment (3 hour) for sulfur dioxide for Canyonlands. Significant degradation of visibility would still occur in class I areas (particularly Canyonlands) and would be unavoidable.

Noise

Under alternative 2A, although mitigative measures to minimize adverse auditory effects (such as hearing impairment) would be required of the applicants, the amount of noise generated due to operation of a 308-wellfield, a refinery-type upgrading facility, and increased road traffic in an essentially rural, quiet area would be a significant and unavoidable impact on both residents and visitors to Glen Canyon, Canyonlands, and BLM WSAs, as well as on wildlife populations in the vicinity of the proposed federal lease unit. Under alternative 2B, impacts within BLM WSAs would be reduced, as no development would occur in those areas, but noise intrusions from development on adjacent BLM and NRA lands would still occur. Under alternative 2C, impacts within Glen Canyon would be reduced (except for those attributable to traffic on access roads within the recreation area), as would impacts within Canyonlands, but noise intrusions from development on neighboring lands would be unavoidable.

Scenic Quality

Applying additional protective restrictions under alternative 2A would further reduce adverse effects, but major alterations of the scenic character of the unit would still occur. Over time, the scenic character would change from essentially natural to a landscape where human alteration is very evident and predominant. Under alternative 2B, such effects would not occur within the boundaries of the BLM WSAs, but could still be evident from within the WSAs due to development on neighboring lands. Under alternative 2C, impacts on the long-range views from Canyonlands would largely be eliminated, but impacts on the scenic character of Glen Canyon would still occur (though moderated) due to the nature of the terrain and the intensity and intrusiveness of development

activities on neighboring lands. Impacts associated with progressive vegetation removal for wellfield development, the upgrading facilities, and ancillary facilities (including roads, pipelines, and waste disposal sites) would be unavoidable and would endure for many years.

Cultural Resources

The applicants would be required to mitigate direct impacts on the most significant known archeological resources, since the lease unit is in an area containing one of the highest known concentrations of archeological sites on the Colorado Plateau. Under alternatives 2A and 2B, large amounts of known in-context materials would be destroyed and the complex of sites in the proposed Orange Cliffs Multi-Resource National Register property would be irrevocably altered. An estimated 885 sites would be unavoidably affected under alternative 2A, 530 sites under alternative 2B, and 545 sites under alternative 2C. Under alternative 2C, such effects on known in-context materials would be minimized, but adverse effects on the overall character of the complex of sites comprising the proposed National Register property would still occur for an estimated 545 sites on BLM lands. Mitigation of damage to every site within the proposed federal lease unit would still result in a net loss of scientific data and interpretive potential. The destruction of in-context cultural remains would be significant and unavoidable.

Unavoidable adverse secondary effects due to the influx of large numbers of people (both the applicants' employees and families, and increased numbers of visitors and recreationists), ranging from increased wear-and-tear on fragile resources to unauthorized collection and vandalism, would occur under alternatives 2A, 2B, and 2C. The resources lost or damaged, particularly the highly significant and unique rock art, would be irreplaceable, and such effects cannot be mitigated.

Socioeconomics

Though the number of applicants' employees would be reduced under alternatives 2A, 2B, and 2C, a significant increase in population would still occur in southeast Utah (to an estimated 390 in the initial peak workforce year). The applicant would be required to comply with state of Utah restrictions regarding mitigation of socioeconomic impacts, but there likely would be a lag time between the initial influx of people into a currently rural and undeveloped region and the construction and provision of necessary infrastructure and services. In addition, the cyclical nature of the project would prompt "boom and bust" cycles. A large construction workforce, as compared to an operational workforce (367 construction workers, and 58 operational workers), would be required, and services and infrastructure would either have to be developed to serve this transient population, or shortfalls would result. Local individuals who could obtain employment in project activities would benefit from the project, but those in local communities who are living on fixed incomes or employed in traditional occupations may suffer from local price inflation (particularly in the cost of housing and services). As insufficient workforce currently exists in the region to provide workers for project activities, and

as specialized skills would be required, a large influx of outsiders is expected. Such a large increase in population would essentially destroy the traditional cultural homogeneity of the towns and counties in the vicinity of the proposed federal lease unit.

Land Use

If all required mitigation and additional restrictions are imposed, the project under alternatives 2A and 2B would be in conflict with NPS land use plans and management goals. Under alternatives 2A and 2B, major tar sand development activities would still occur on NRA lands, and, as previously discussed, such activities would have major unavoidable adverse impacts on recreational use within Glen Canyon and Canyonlands. Under alternative 2C, direct impacts (except those related to access) would largely be eliminated on NRA lands, but spillover effects on scenic resources, air quality, water resources, and other such resources would still occur.

Alternatives 2A and 2B would not be in conformance with present BLM land use plans, as the BLM lands within the proposed unit are currently classified as category 1 lands (lease with standard stipulations only). However, the land use plans could be changed as a result of this EIS process (see the discussion in the "Environmental Consequences" section of alternative 1). Alternative 2B would not be in conformance with present BLM land use plans and multiple use objectives, as a portion of the BLM lands within the unit would not be available for mineral development compatible with other multiple uses such as grazing and recreation, but would be consistent with protection of WSAs from changes that could impair suitability for wilderness designation. If the land use plans are changed as previously discussed, alternatives 2A and 2B would be in conformance with BLM land use policies and management objectives.

Recreation and Wilderness Values

If all required mitigation is imposed, as well as all additional protective restrictions, under alternative 2A, the project would have major unavoidable adverse impacts on the type and quality of recreational experience of visitors to Glen Canyon and the western portions of Canyonlands (an estimated 500,000 visitors over the life of the project, if visitation remains at present levels). Direct impacts due to placement of project components would occur in Glen Canyon NRA under alternatives 2A and 2B, and indirect impacts due to spillover impacts (i.e., those that do not respect geographic boundaries, such as air emissions, noise, lighting intrusions, and odors) would occur in Canyonlands NP under all three alternatives (2A, 2B, and 2C). Under alternative 2B, recreational and wilderness values within the BLM WSAs would be protected from direct effects, but spillover impacts could still occur. Under alternative 2C, direct adverse effects on recreational use within Glen Canyon and Canyonlands would be minimized. However, indirect effects due to noise, air pollution, water resource conflicts, and other activities resulting from development on neighboring lands would be unavoidable. As access alternatives are limited due to terrain constraints, traffic, and other access conflicts between the applicants' vehicular traffic and recreationists would occur and be unavoidable.

The desirability of the area for hunting would be reduced for all the alternatives, as would hunting success, and the resultant impact on Utah recreationists (97 percent of the deer hunters in the vicinity of the unit in 1982 were Utah residents) would be unavoidable.

LONG-TERM ENVIRONMENTAL CONSEQUENCES

Relationship of Short-Term Uses of the Environment and Enhancement of Long-Term Productivity

Phases I, II, and III would not under present levels of knowledge have significant long-term effects on the environment or on productivity. Given that the projected life of the tar sand development project proposed by the applicants if leases are converted would be up to 160 years at the commercial development stage, or phase IV, (and, under a reduced production scenario, could be even longer), all unmitigated impacts previously discussed must be considered to be long term. In particular, the unavoidable adverse impacts on water resources, wildlife, vegetation, air quality related values (such as visibility), cultural resources, and recreational and wilderness values would be significant and long term.

The short-term goal that would be achieved would be development of a new technology for extraction of a previously inaccessible hydrocarbon fuel resource. Up to 5,000 bpd of bitumen (3,450 bpd of syncrude to market) would be produced during the commercial development phase; this would contribute to the total amount of domestic petroleum products available in the U.S., providing that existing technological and economic problems can be overcome.

Irreversible/Irretrievable Commitments of Resources

Converting the leases and resultant tar sand development could result in either the irreversible or irretrievable commitment of resources. An irreversible commitment of a resource is one that cannot be changed once it occurs, and an irretrievable commitment means that the resource cannot be recovered or reused. Irreversible and irretrievable commitments of resources resulting from lease conversion and tar sand development as proposed in alternatives 2A, 2B, and 2C are presented in table 54.

Table 54: Alternatives 2A, 2B, and 2C - Irreversible/Irretrievable Commitments of Resources

Resource	Resource Commitments
Energy and Minerals	Bitumen removed from the tar sand deposit would be consumptively used, constituting an irreversible and irretrievable resource commitment.
Water Resources	Water used for tar sand development would not be available for other uses and would be irretrievably committed for that time period; such commitment would be irreversible as to the amount of water lost due to water quality degradation in the wastewater stream and disposal to a poor-quality underground formation.
Soils and Vegetation	Soil losses due to erosion and vegetative production lost due to changes in land use would be irretrievable losses. Alternatives 2A, 2B, and 2C differ in the acreage affected.
Wildlife	Wildlife habitat and production particularly bighorn and raptors) within the proposed unit would be lost for the operational life of the project, plus during the time necessary for reclamation and revegetation; such loss may be irreversible for some species (particularly eagles and bighorn sheep).
Scenic Quality	Due to the large-scale and permanent changes in topographic features and the long-term changes in vegetative cover and growth patterns, irretrievable impacts on the landscape character and the scenic resources would result.
Cultural Resources	Destruction of in-context archeological remains would be unavoidable as the project progresses; such loss of data and resources is permanent, irreversible, and irretrievable. The specific sites and acreages affected vary under alternatives 2A, 2B, and 2C.
Socioeconomic Environment	Changes in the character and composition of the surrounding rural communities and counties would be irreversible.

Resource	Resource Commitments
Land Use	Up to 265 acres of the unit at any one time would be committed to mineral development to the exclusion of other multiple uses, notably recreation use and grazing; this would constitute an irretrievable commitment of the land base to a single use. For NPS lands, the primary management purpose of providing primitive and unconfined recreation would not be achievable during the life of the project under alternatives 2A and 2B; this would constitute an irretrievable commitment of the land base to a subordinate purpose for a long period of time.
Recreation and Wilderness Values	The amount of land where one can go to experience solitude or to enjoy primitive and unconfined recreational experiences would be reduced by up to 23,541 acres; the change in character of the reccreational lands from primarily undeveloped and natural to primarily industrialized would be irreversible for the lands where leases are converted. The acreages directly disturbed differ for alternatives 2A, 2B, and 2C.

ALTERNATIVE 3: DENY CONVERSION OF ALL LEASES (NO ACTION)

Any existing federal oil and gas leases not converted to combined hydrocarbon leases would remain valid oil and gas leases until the expiration of their original term and could still be developed for oil and gas. Nonconversion opens the possibility of future competitive leasing. Such leasing activity would be predicated upon additional environmental compliance work to determine leasing and development suitability.

IMPACTS ON NATURAL ENVIRONMENT

Occasional oil and gas drilling could continue to occur sporadically, at relatively low levels consistent with historic activity levels in the area. The impacts of such activity cannot be accurately predicted, as the location and intensity of such activity is not known, but the level of impacts would be minor compared to those generated by full-scale tar sand development within the proposed federal lease unit. The impacts of such activity would be assessed on a case-by-case basis as specific proposals are received.

Up to 20,700 bpd of syncrude would not be available for development from the lease unit. The resource would remain in place for future development under the competitive leasing system. Lands within leases covered by the present conversion application that are not converted would remain as valid oil and gas leases until the expiration of their original terms and could be eligible for competitive leasing in the future. Any development resulting from such action would be evaluated at the time it was proposed.

The natural environment within the proposed federal lease unit would remain in its present condition. If the no-action alternative is implemented and the leases within the proposed federal lease unit are not converted, no adverse impacts on air quality are expected. The air quality and meteorology of the area would remain as described in the "Affected Environment" section of this document. No other projects are planned or are being constructed in the area that would be close enough to impact the area surrounding the proposed federal lease unit other than similar lease conversions for tar sand resources.

IMPACTS ON CULTURAL RESOURCES

Under this alternative, the historic resources and the numerous archeological remains in the proposed unit and vicinity would continue to be protected and preserved at the present time because of the low level of development activities in the area and continued low levels of visitation.

Eventual development of individual leases would entail project-specific archeological surveys, resource evaluations, and appropriate mitigation where archeological remains cannot be avoided. This would result in a much more limited impact on regional archeological resources than would occur under either the proposed action (alternative 1) or the modified proposal (alternatives 2A, 2B, and 2C). The adverse impacts under this alternative would be limited to those

resulting from development of existing oil and gas rights on individual leases or from possible future competitive leasing and would be dealt with under project-specific environmental assessments if and when such development is proposed.

IMPACTS ON SOCIOECONOMIC ENVIRONMENT

Because levels of activity in the area, no additional impact on the socioeconomic characteristics of the region are anticipated. However, up to 2,400 new jobs generated by the tar sand development as proposed by the applicants would be foregone. Any expected profits and anticipated return on investment by the applicants would also be foregone. If tar sand development becomes economically feasible in the future, the area could be leased competitively, and the tar sand could then be developed by these applicants or by others.

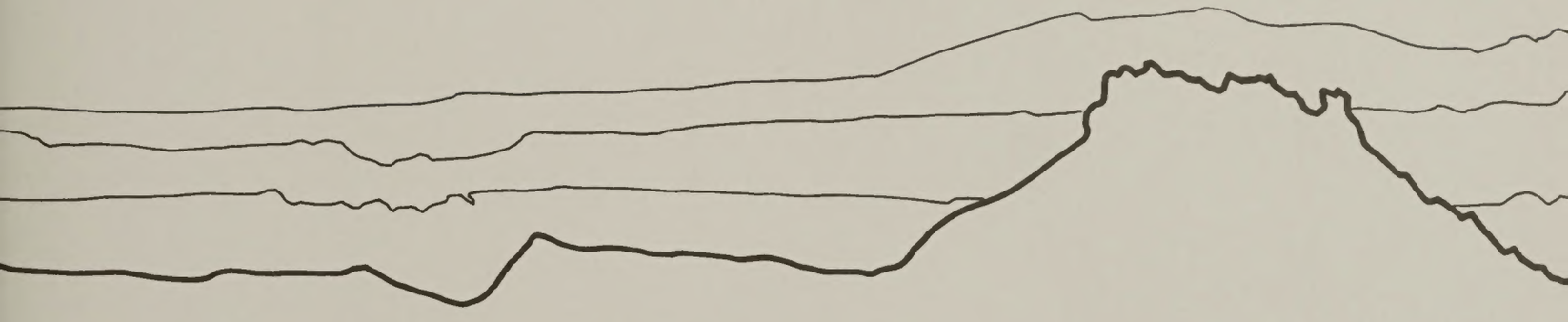
IMPACTS ON LAND USE

Denying all lease conversions would not affect existing proposed lease unit landownership patterns and would be in compliance with all applicable local, state, and federal land use plans and controls for the proposed federal lease unit.

IMPACTS ON RECREATION AND WILDERNESS VALUES

Denying all lease conversions would not affect recreation and wilderness values within the proposed federal lease unit. Occasional oil and gas activity is consistent with past practices in the area. Specific proposals for oil and gas activities would be assessed on a case-by-case basis for their impacts on recreation and wilderness.

CONSULTATION AND COORDINATION



INTRODUCTION

The Tar Sand Triangle DEIS was prepared jointly by specialists from the NPS Energy, Mining and Minerals Division, the Denver Service Center, Rocky Mountain Regional Office, Glen Canyon National Recreation Area, and Canyonlands National Park; and from the BLM Oil Shale Team in Grand Junction, Colorado, the Utah State Office, and the Richfield District Office. Disciplines and skills applied in this DEIS were resource management and planning, environmental engineering, archeology, ecology, air quality analysis, hydrology, wildlife biology, botany, geology, soils, reclamation, mining engineering, process engineering, public affairs, computer graphics, and text processing.

A digital cartographic data base was prepared for this project by the Digital Cartography Program at the NPS Denver Service Center. Data sources included digital mapfiles obtained from existing FWS data bases, existing cartographic information in analog form (which was reviewed for accuracy, georeferenced, and converted to digital form), and cartographic information developed and digitized by the NPS. Digital mapfiles were edited, analyzed, and displayed using a software package (SAGIS) developed by Peter Strong, FWS. Acreage figures for the various themes and categories were obtained using SAGIS and were combined to produce derived themes for analytical purposes. High quality black and white plots were produced on mylar at various scales, both for analytical purposes and as illustrations for this DEIS.

SCOPING PROCESS AND ISSUES

SCOPING PROCESS

On January 4, 1983, the NPS published in the Federal Register (48 FR 350) a Notice of Intent to prepare an EIS. That notice invited the state of Utah and appropriate federal agencies to participate in preparing the EIS. Subsequently, pursuant to agreement between the agencies, a determination was made that the EIS would be jointly prepared by the NPS and the BLM, with the NPS having the lead responsibility for document preparation. The notice also pointed out that the FEIS must be completed by March 15, 1984.

The January 4 notice tentatively identified four alternatives that would be considered in the EIS: (1) deny conversion of all leases (no action), (2) convert all leases based on the plan of operations submitted by the applicants, (3) convert leases based on the existing plan, but with additional protective stipulations, and (4) convert only those leases lying outside the boundaries of Glen Canyon National Recreation Area.

A number of meetings were held with the proposed federal lease unit applicants to identify and clarify data needs for EIS preparation. These meetings resulted in several additional analyses and studies (including threatened and endangered species surveys, archeological surveys, paleontological surveys, air quality analyses, and socioeconomic studies) to be made by the EIS team or consultants. The relationship between the timing of the EIS preparation and the March 15, 1984, date for action by BLM on lease conversions was indicated in a "Task Directive/Preparation Plan" that was approved by BLM on April 14, 1983, and NPS on April 21, 1983.

The Federal Register notice also identified a number of issues and impacts to be addressed in the EIS and invited the public to suggest other issues, alternatives, or impacts. On March 1, 1983, an announcement of scoping meetings was published in the Federal Register (48 FR 8599). Scoping meetings were held at Hanksville, Utah, on March 9 and in Salt Lake City, Utah, on March 10, 1983.

SIGNIFICANT ISSUES

The entire scoping process identified the issues that are deemed to be significant. These issues are addressed in depth in this DEIS as follows:

ISSUE	RESPONSE
Identify criteria to be used in making the decision whether to convert the leases.	Criteria are discussed in the "Purpose and Need" and "Environmental Consequences" sections.
Discuss the effects on geology, particularly those resulting from the underground fracturing and extraction processes.	These are addressed in the "Geologic Resources" and "Water Resources" portions of the "Environmental Consequences" section.

ISSUE	RESPONSE
Discuss the effects on paleontology, both from possible direct disturbance by tar sand development activities and by indirect impacts from unauthorized collection of fossil resources by an increased human population using the area.	These effects are discussed for each alternative in the "Paleontology" portion of the "Environmental Consequences" section.
Discuss the effects on energy and minerals, including the direct effects of the removal of the tar sand.	The DEIS considers all the proposed phases of development outlined in the applicants' plan of operations and includes applying additional protective measures to reduce impacts.
Discuss the effects on water resources, including potential changes in the quality and quantity of groundwater and surface water; water requirements for the phased tar sand development, sources of water, and similar concerns.	These effects are discussed in the "Water Resources" portions of the "Environmental Consequences" section.
Discuss the effects on air quality both class I areas (such as Canyonlands National Park) and class II areas, particularly for phase IV of the proposed development.	Impacts discussed include those due to sulfur dioxide, particulate matter, nitrogen oxides, and other pollutants. Air quality modeling (as detailed as possible considering the limited amount of information available) was done, and the results are analyzed in the "Air Quality" portion of the "Environmental Consequences" section.
Discuss the effects of noise from machinery and truck traffic, both at the construction stage and the operational stage, as it affects workers, the residents at Hans Flat, and recreationists.	Impacts discussed include both auditory and nonauditory effects on humans and wildlife. The analysis is summarized in the "Noise" portion of the "Environmental Consequences" section and in appendix G.
Discuss the effects of the proposed development on scenic quality.	A computer analysis based on terrain characteristics was performed. The results are discussed in the "Scenic Values" portion of the "Environmental Consequences" section.
Discuss the effects of the proposed development on soils.	The impacts of soil disturbance and the implications for effective reclamation of the area are discussed in the "Soils" portion of the "Environmental Consequences" section.

ISSUE	RESPONSE
Discuss the effects of the proposed development on vegetation, because full development could mean removing large portions of the climax pinyon-woodland, the most widespread vegetative community present in the proposed federal lease unit.	The total amount of vegetative disturbance is discussed, as well as the potential for impacts on threatened and endangered species and the juniper revegetation/reclamation potential in the "Vegetation" portion of the "Environmental Consequences" section.
Discuss the effects on wildlife and management objectives for reestablishing desert bighorn sheep in Canyonlands National Park, as well as within Glen Canyon National Recreation Area.	The impacts on wildlife (including NPS threatened and endangered species) area are discussed in the "Wildlife" portion of the "Environmental Consequences" section, and the impact on human use of wildlife resources is discussed in the "Hunting" portion of the "Environmental Consequences" section.
Discuss the effects on archeological resources.	Both direct and indirect effects on the archeological resources of the proposed federal lease unit and its environs are discussed in the "Cultural Resources" portion of the "Environmental Consequences" section.
Discuss the effects of the proposed development on the local social and economic structure, because the proposed action would result in the influx of large numbers of people into an area that currently has low population levels and little social infrastructure	The impacts discussed in the "Socioeconomics" portion of the "Environmental Consequence" section include both the beneficial and detrimental effects of development on the local economy and social structure. Modeling of potential socioeconomic impacts was done using the UPED model, and the results are analyzed in the Socioeconomics" portion of the DEIS.
Discuss how the products from this operation are to be transported, as the project area is isolated and currently is no transportation network available.	Impacts discussed in the "Transportation and Access" portion of the "Environmental Consequences" include the possible need for a product pipeline and upgraded roads. Secondary impacts--more people, more traffic--are also discussed.
Discuss how the proposal would affect NPS and BLM management goals for the area, and whether additional staff would be needed to monitor operations.	The impacts on NPS and BLM management goals are discussed in several portions of the "Environmental Consequences" section; effects on staffing are discussed in the "Socioeconomics" section.

ISSUE	RESPONSE
Discuss how the proposal would affect other programs in the area, including grazing and visitor use, and potential for other types of mineral development or leasing activities.	These effects are discussed in the "Grazing," "Recreation," and "Energy and Minerals" portions of the "Environmental Consequences" section.
Discuss how the proposal would affect the BLM WSAs that lie partially within the proposed federal lease unit.	Effects are discussed in the "Wilderness" and "Land Use" portions of the of the "Environmental Consequences" section.
Discuss how the proposal would affect administration of Glen Canyon National Recreation Area for recreational use, particularly in Orange Cliffs area, and discuss what effects the proposal would have on Canyonlands National Park.	The direct and indirect impacts on the recreation and other resources of Glen Canyon National Recreation Area and Canyonlands National Park are the discussed in the "Recreation" portion and throughout the "Environmental Consequences" section.

ISSUES BEYOND THE SCOPE OF THIS DEIS

The scoping process also identified certain issues that, although important, are not appropriate for discussion in this DEIS. These issues include the following:

ISSUE	RESPONSE
Discuss the necessity for each phase of the proposal, the level of existing knowledge, and whether existing data would be adequate.	These decisions would be made if and when the leases are converted and the applicants stand ready to actually go out and develop the leases; they are not a part of the initial decision whether to convert leases at all.
Discuss the delay in tar sand development that is caused by the environmental review process.	Environmental review is a necessary prerequisite for conversion under the language of the law (the Combined Hydrocarbon Leasing Act and the National Environmental Policy Act), and the advisability of such legislative policy is not an issue for discussion in this DEIS.
Keep the state of Utah involved in all phases of lease conversion and in subsequent development operations.	The state of Utah has been consulted in the preparation of the DEIS, and issues of state concern have been addressed at several points. As required by law, the state will be kept informed of future planned activity on any of the leases.

Other issues beyond the scope of this DEIS are being addressed in the Utah Combined Hydrocarbon Leasing Regional EIS concurrently being prepared by BLM. These issues include the following:

Rank all 11 STSAs within Utah in priority for development, and place areas that are not very sensitive first, so they could be used for experimenting with new technologies.

Discuss whether development of tar sand could help offset dependence on foreign sources of oil.

AGENCIES AND ORGANIZATIONS CONSULTED

The Tar Sand Triangle EIS team consulted and received comments from the following during the preparation of this DEIS. Written comments received during the scoping process and the preparation of the DEIS are on file at the Rocky Mountain Regional Office, National Park Service, 655 Parfet Street, P.O. Box 25287, Denver carbon monoxide 80225. Other informal consultation was carried out throughout the preparation process. Comments and suggestions received are reflected in the DEIS.

BUSINESS AND INDUSTRY

Tar Sand Triangle Applicants
- Santa Fe Energy Company
- Benson-Montin-Greer
- Altex Oil Company
- Gulf Oil Corporation
- Rex L. Randolph
- The Ogle Corporation
- Warren A. Morton
- Colman M. Mockler, Jr.
- Rush B. Locke
- Lee M. Grace
- Bill D. Farleigh Oil and Gas Properties
- Steve C. Champlin
- Hawthorn Oil Company
- Edmundson, Inc.
- John M. Beard
- Southland Royalty Company
- CAF Company

Sam Oil, Inc.

Nickens and Associates
Brigham Young University
University of Denver
Argonne National Laboratory

STATE AGENCIES AND ORGANIZATIONS

Utah Division of Oil, Gas and Mining
Utah State Historic Preservation Officer
Utah Division of Wildlife Resources
Utah State Paleontologist

FEDERAL AGENCIES

Department of Agriculture
    Soil Conservation Service
Department of the Interior
    Office of the Solicitor
    Fish and Wildlife Service
        (Section 7-see correspondence in this section)
    National Advisory Council on Historic Preservation
        (see correspondence in this section)

ORGANIZATIONS

National Parks and Conservation Association
Natural Resources Defense Council, Inc.
Sierra Club
The Wilderness Society

INDIVIDUALS

Reo Hunt
Riter Ekker
Bret Blosser
Michael Salamacha
Joseph A. Leonard
Mark Morfey

United States Department of the Interior
FISH AND WILDLIFE SERVICE
ENDANGERED SPECIES OFFICE
1406 Federal Building
125 South State Street
Salt Lake City, Utah 84138

IN REPLY REFER TO:

20 May 1983

MEMORANDUM

TO: Associate Regional Director, Planning and Resource Preservation,
Rocky Mountain Region, National Park Service
Attention: Ms. Toni Ristou (DSP-SP)

FROM: Field Supervisor, Endangered Species Office,
Salt Lake City, Utah

SUBJECT: Endangered Species List for Tar Sands Development EIS in Garfield and Wayne Counties, Utah.

We have reviewed your memorandum of 12 April 1983. It appears that listed endangered and threatened species, or species proposed for listing, may occur in the area of influence of this action.

To comply with Section 7(c) of the Endangered Species Act of 1973, as amended (ESA), Federal agencies or their designees are required to obtain from the Fish and Wildlife Service (FWS) information concerning any species, listed or proposed to be listed, which may be present in the area of a proposed construction project. Therefore, we are furnishing you the following list of species which may be present in the concerned area:

peregrine falcon	Falco peregrinus
bald eagle	Haliaeetus leucocephalus
black-footed ferret	Mustela nigripes
Colorado squawfish	Ptychocheilus lucius
humpback chub	Gila cypha
Wright fishhook cactus	Sclerocactus wrightiae

In addition to the above mentioned species the following are species which are under review by the U. S. Fish and Wildlife Service for possible listing, (see Federal Register Vol. 45 No. 242 15 December 1980 and Vol. 47 No. 251 30 December 1982).

Erigonum smithii	Coccyzus americanus occidentalis
Astragalus momumentatis	Strix occidentalis lucida
Cycladenia humilis var jonesii	Euderma maculatum
Phacelia indecora	

These species are not protected at present under the ESA we do, however, encourage you to consider them in your environmental planning and decisions.

Section 7(c) also requires the Federal agency proposing a major Federal action significantly affecting the quality of the human environment to conduct and submit to the FWS a biological assessment to determine the effects of the proposal on listed and proposed species. The biological assessment shall be completed within 180 days after the date on which initiated or a time mutually agreed upon between the agency and the FWS. Before physical modification/alternation of a major Federal action is begun the assessment must be completed. If the biological assessment is not begun within 90 days, you should verify this list with us prior to initiation of your assessment. We do not feel that we can adequately assess the effects of the proposed action on listed and proposed species or critical habitat and proposed critical habitat without a complete assessment. When conducting a biological assessment, you shall, at a minimum:

1. conduct a scientifically sound on-site inspection of the area affected by the action, which must, unless otherwise directed by the FWS, include a detailed survey of the area to determine if listed or proposed species are present or occur seasonally and whether suitable habitat exists within the area for either expanding the existing population or potential reintroduction of populations;

2. interview recognized experts on the species at issue, including those within the Fish and Wildlife Service, state conservation agencies, universities, and others who may have data not yet found in scientific literature;

3. review literature and other scientific data to determine the species' distribution, habitat needs, and other biological requirements;

4. review and analyze the effects of the action on the species, in terms of individuals and populations, including consideration of the cumulative effects of the action on the species and habitat;

5. analyze alternative actions that may provide conservation measures;

6. conduct any studies necessary to fulfill the requirements of (1) through (5) above;

7. review any other relevant information.

You may wish to include your biological assessment into your draft or final EIS or prepare a separate document.

The FWS can enter into formal Section 7 consultation only with another Federal agency or its designee. State, county, or any other governmental or private organizations can participate in the consultation process, help prepare information such as the biological assessment, participante in meetings, etc.

After your agency has completed and reviewed the assessment, it is your responsibility to determine if the proposed action "may affect" any of the listed species or critical habitats. You should also determine if the action is likely to jeopardize the continued existence of proposed species or result

in the destruction or an adverse modification of any critical habitat proposed for such species. If the determination is "may affect" for listed species you must request in writing formal consultation from the Field Supervisor, Endangered Species Office, U.S. Fish and Wildlife Service at the address given above. In addition, if you determine that the proposed action is likely to jeopardize the continued existence of proposed species or result in the destruction or adverse modification of proposed critical habitat, you must confer with the FWS. At this time you should provide this office a copy of the biological assessment and any other relevant information that assisted you in reaching your conclusion.

Your attention is also directed to Section 7(d) of the Endangered Species Act, as amended, which underscores the requirement that the Federal agency or the applicant shall not make any irreversible or irretrievable commitment of resources during the consultation period which, in effect, would deny the formulation or implementation of reasonable and prudent alternatives regarding their actions on any endangered or threatened species.

We are prepared to assist you whenever you have questions which we may be able to answer. If we can be of further assistance, please advise us.

The FWS representative who will provide you with technical assistance is Larry England (801) 524-4430; FTS 588-4430.

Fred L. Bolwahnn

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Ecological Services
2934 W. Fairmount Avenue
Phoenix, Arizona 85017

2-21-83-I-53

September 13, 1983

Mr. Alex R. Carter, Acting Chief
Environmental Assessment Branch
Energy, Mining and Minerals Division
National Park Service
P. O. Box 25287
Denver, Colorado 80225

Dear Mr. Carter:

This is in response to your letter dated August 23, 1983 (your reference N3615(480)) concerning the Tar Sand Triangle Environmental Impact Statement. As provided by Section 7 of the Endangered Species Act, the Fish and Wildlife Service furnishes, upon request, a list of federally listed and proposed species that may be affected by Federal actions. We have used the information in your request to narrow the list of listed and proposed species which occur in Coconino County, Arizona, to those that potentially may be affected by your proposed action (see enclosure). Your concern was for species downstream of Glen Canyon Dam on the Colorado River that may be affected by withdrawals in Garfield and Wayne Counties, Utah.

If the Federal action is considered a major action significantly affecting the quality of the human environment, the Federal agency authorizing, funding, or carrying out the Federal action will conduct a biological assessment to determine whether or not the Federal action will affect listed or proposed species. Preparation of the assessment may begin upon receipt of the Fish and Wildlife Service's species list.

The biological assessment shall be completed within 180 days after receipt of the species list, unless it is mutually agreed to extend this period. If the assessment is not initiated within 90 days after receipt of the species list, we suggest its accuracy be verified before conducting the assessment.

The biological assessment should include as a minimum:

1) onsite inspection of the area affected by the proposed activity or program, including a detailed survey of the area to determine if species are present and whether suitable habitat exists for either expanding the existing population or potential reintroductions of populations;

2) interviews with recognized experts on the species at issue, including personnel of the Fish and Wildlife Service, of State conservation departments, of universities, and others who may have data not yet found in scientific literature;

3) review literature and other scientific data to determine the species distribution, habitat needs, and other biological requirements;

4) review and analysis of the effects of the proposed action on individuals and populations, including consideration of both direct and indirect effects of the proposal on the species and its habitat;

5) analysis of alternative actions that may promote conservation of the species;

6) other relevant information;

7) written report documenting the assessment results.

If the Federal permitting action is not a major action significantly affecting the quality of the human environment, there is no need to prepare a biological assessment. However, it remains incumbent upon the Federal agency to assess whether its action may affect endangered and threatened species.

If the Federal agency determines that its proposed action may affect listed species, the Federal agency shall initiate the formal Section 7 consultation process by writing to this office. If no effect is evident, there is no need for further consultation. However, we would appreciate the opportunity to review your biological assessment.

If you have need of further assistance, please call this office at FTS 261-2493.

Sincerely yours,

Field Supervisor

Enclosure

cc: Director, Arizona Game and Fish Department, Phoenix, Arizona
Superintendent, Glen Canyon National Recreation Area, Page, Arizona
Regional Director, (SE), Fish and Wildlife Service, Albuquerque, New Mexico

Tar Sand Triangle Development
Coconino County, Arizona

Listed Species

Humpback chub	*Gila cypha*	Found in the Colorado River in Grant and Marble Canyons and in the Little Colorado River.

Proposed Species

None

Critical Habitat

None

Advisory
Council On
Historic
Preservation

1522 K Street. NW
Washington. DC 20005

Reply to:

March 11, 1983

Mr. Roland G. Robison
State Director
Bureau of Land Management
University Club Building
136 E. South Temple
Salt Lake City, UT 84111

Dear Mr. Robison:

The Advisory Council has received your letter of February 9 requesting that we participate in the preparation of a joint environmental statement of the Bureau of Land Management and National Park Service for converting oil and gas leases to combined hydrocarbon leases within and adjoining Glen Canyon National Recreation Area in Utah.

It is the Council's policy that it will not normally act as a cooperating agency within the meaning of 40 CFR 1500-1508. Most of the activities related to the preparation of the draft environmental statement (DES), such as scoping, lie outside the Council's statutory authority and area of expertise. Only in those cases where a DES is prepared concerning the implementation of agency programs, for area-wide planning, such as mineral or energy leasing involving several States, or for projects not related to a specific, limited, area or site, would the Council be able to assist a lead agency in meeting its obligations to protect historic and cultural properties. Where a DES is to be concerned with the impacts of a specific action or related to a specific, limited, area or site, the Council would be able to do little more than ensure that the processes set forth in its regulations are complied with. The Council has specified procedures within its regulations (36 CFR 800) which, if followed by a lead agency, allow the agency to meet its statutory obligations under Section 101(b)(4) of NEPA and Section 106 of the National Historic Preservation Act. The Council's regulations (36 CFR 800.4) specify what must be considered during scoping where a DES is to be concerned with a specific action. Thus, if the Council were to act as a cooperating agency in this instance, it would be able to do little more than ensure that the Park Service and Bureau fully comply with 36 CFR 800.4.

The requirement embodied in Section 101(b)(4) of NEPA to "preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment which supports diversity and variety of individual choice" is separate and distinct from the requirement embodied in Section 106. While both the regulations of CEQ (40 CFR 1502.25) and the regulations of the Council (36 CFR 800.9)

prescribe that the processes embodied in NEPA and Section 106 should be integrated to the fullest extent possible, the two statutes establish separate requirements and any preferred alternative selected in the preparation of the DES may not necessarily incorporate the comments of the Council developed through the consultation process outlined in 36 CFR 800.6. It is the intent of the Council as expressed in 36 CFR 800.9 to have the Section 106 commenting process run concurrently with the NEPA review process and for the final environmental statement to incorporate the comments of the Council rendered pursuant to 36 CFR 800.6.

The Council's statutory authority under Section 106 provides for Council comments only in those undertakings affecting National Register or eligible properties. The identification of such properties, whether listed in, already eligible for listing in, or potentially eligible for listing in the National Register of Historic Places is a function of the agency working in consultation with the Utah State Historic Preservation Officer (SHPO) and the National Park service's out-house preservation programs. It would be appropriate for you to invite the Utah SHPO to take part in scoping.

If we may be of any further assistance during the preparation of the DES, please feel free to contact Brit Allan Storey of my staff at (303) 234-4946, a FTS number.

Sincerely,

B.A. Storey

Louis S. Wall
Chief, Western Division
of Project Review

LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THE STATEMENT ARE SENT

FEDERAL AGENCIES

Department of Agriculture
- Economic Research Service
- Farmers Home Administration
- Soil Conservation Service
- Agricultural Stabilization and Conservation Service

Department of Commerce
Department of Defense
Department of Energy
- Western Power Administration
- Federal Energy Regulatory Commission

Department of Housing and Urban Development
Department of the Interior
- Bureau of Indian Affairs
- Bureau of Mines
- Bureau of Reclamation
- Fish and Wildlife Service
- Geological Survey

Department of Labor
Department of Transportation
Environmental Protection Agency
National Advisory Council on Historic Preservation
Upper Colorado River Commission
Utah Congressional Delegation

STATE AGENCIES

Arizona State Clearinghouse
Utah Governor's Office
Utah State Clearinghouse
Utah State Legislators, as appropriate

LOCAL GOVERNMENT

Five County Association of Governments
Garfield County Commission
Six County Commissioners' Organization
Utah Association of Counties
Wayne County Commission
Wayne County School District

EDUCATIONAL ORGANIZATIONS

Brigham Young University
Colorado State University Library
Denver Public Library
Northwestern University
Salt Lake City Public Library
University of Colorado Library
University of Denver
    Department of Sociology
University of Utah
Utah State University
Weber State College

INDIAN TRIBES

Council of Energy Resource Tribes
Navajo Indian Tribe
Ute Indian Tribe

ORGANIZATIONS

American Right-of-Way Association
Archeological Society of Utah
Council on Utah Resources
Defenders of Outdoor Heritage
Desert Protective Council
Earth First
Environmental Defense Fund
Four Corners Regional Tourism Council
Four Corners Wilderness Workshop
Friends of the Earth
Issue
National Audubon Society
National Parks and Conservation Association
National Resources Defense Council, Inc.
National Wildlife Federation
Save Our Canyons Committee
Sierra Club
The Nature Conservancy
The Wilderness Society
Utah Association of Soil Conservation Districts
Utah Audubon Society
Utah Cattlemen's Association
Utah Environment Center
Utah Geological Association

Utah Petroleum Association
Utah Water Pollution Control Association
Utah Water Resources Council
Utah Water Users Association
Utah Wildlife Federation
Utah Wilderness Association
Utah Wilderness Coalition

BUSINESS AND INDUSTRY

Aerocomp, Inc.
Atlas Minerals
Santa Fe Energy Company
Altex Oil Company
Gulf Oil Corporation
Benson-Montin-Greer
Sun Exploration and Production Company
HOC 1982 Rockies Oil Program Limited Partnership
Hershey Oil Corporation
Cordillera Corporation
David W. Evans, Inc.
Deseret News
Salt Lake City Tribune
Emery County Progress
Richfield Reaper
KALL Radio
KRCL Radio
KSVC Radio
KSL-TV
KTVX
Rex L. Randolph
The Ogle Corporation
Warren A. Morton
Colman M. Mockler, Jr.
Rush B. Locke
Lee M. Grace
Bill D. Farleigh Oil and Gas Properties
Steve C. Champlin
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Edmundson, Inc.
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Southland Royalty Company
CAF Company
Sam Oil, Inc.
Nickens and Associates
Argonne National Laboratory
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Agency	Personnel	Discipline	EIS Responsibility
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	Daniel Hamson	Ecologist	Socioeconomics, Scenic Resources, Recreation, Soils; Technical and Graphics Coordination
	Barbara West	Operations Research Analyst (Public Administration)	Introduction, Purpose and Need
Air and Water Quality Division	Mark Scruggs	Physical Scientist	Climate, Air Quality, Air Quality Modeling Supervision
Denver Service Center, Digital Cartography Program	Nancy Thorwardson	Geographer	Digital Cartography, Data Base, Computer Graphics
Rocky Mountain Regional Office	Adrienne Anderson	Regional Archeologist	Archeological Resources
Glen Canyon National Recreation Area	James Holland	Resource Management Specialist (Biological Sciences)	Vegetation, Glen Canyon NRA Operations
	Vic Vieira	Resource Management Specialist (Biological Sciences)	Wildlife, Recreation, Glen Canyon NRA Operations
Canyonlands National Park	Thomas Wylie	Staff Resource Manager (Cultural & Natural Resources)	Wildlife, Recreation, Canyonlands NP Operations
Bureau of Land Management			
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	James D. Rush	Geologist	Geology, Topography, Paleontology
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Utah State Office	Gregory Thayn	Environmental Coordinator (Biological Sciences)	State Office Coordination; Energy and Minerals, Grazing, Wilderness, Wildlife, Recreation
	Ronald Bolander	Environmental Coordinator (Biological Sciences)	Soils, Vegetation, Socioeconomics, Recreation
Fish and Wildlife Service			
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Canyonlands National Park	Peter Parry	Superintendent
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Phoenix Office	Gilbert D. Metz	Field Supervisor, Ecological Services

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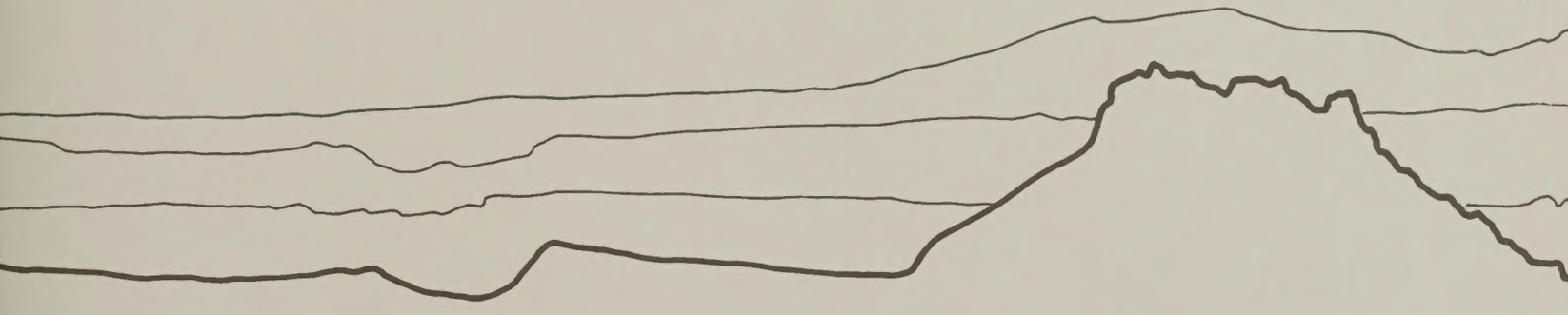

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Abbreviations and Acronyms

EPA	Environmental Protection Agency
UDNR	Utah Division of National Resources
UDOT	Utah Department of Transportation
UDFG	Utah Division of Fish and Game
UDWR	Utah Division of Wildlife Resources
USDA, SCS	U.S. Department of Agriculture, Soil Conservation Service
USDOE, LETC	U.S. Department of Energy, Laramie Energy Technology Center
USDI, BLM	U.S. Department of Interior, Bureau of Land Management
USDI, BOM	U.S. Department of Interior, Bureau of Mines
USDI, FWS	U.S. Department of Interior, Fish and Wildlife Service
USDI, GS	U.S. Department of Interior, Geological Survey
USDI, NPS	U.S. Department of Interior, National Park Service
USDI, NPS, DSC	U.S. Department of Interior, National Park Service, Denver Service Center
USDI, NPS, MWAC	U.S. Department of Interior, National Park Service, Midwest Archeological Center
USDI, NPS, RMR	U.S. Department of Interior, National Park Service, Rocky Mountain Region
USDOT	U.S. Department of Transportation

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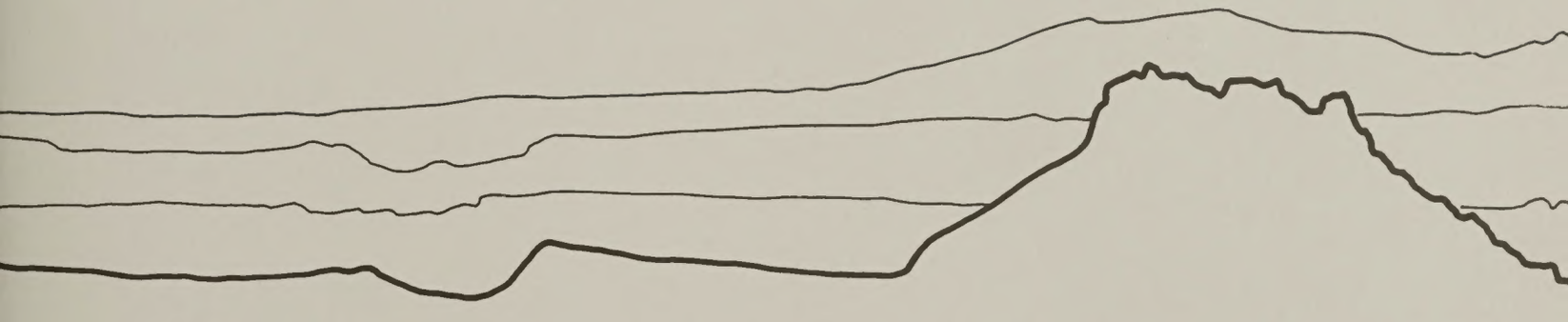
APPENDIXES



APPENDIX A: SUMMARY OF THE FOUR-PHASED DEVELOPMENT FOR THE PROPOSED FEDERAL LEASE UNIT

OVERVIEW OF THE PROPOSED DEVELOPMENT

The plan of operations submitted by the applicants describes a four-phase program ranging from preliminary exploration through full-scale commercial development of the tar sand resource. Phases I and II are primarily exploratory, designed to further define the characteristics and extent of the tar sand deposit within the proposed federal lease unit. Phase III is a pilot-scale project for testing in-situ extraction processes and identifying optimal procedures for producing hydrocarbons from the deposit. The pilot phase would also include testing of upgrading methods on the extracted bitumen at an offsite laboratory. Phase IV is full commercial development, including eventual development of the entire leased acreage for extraction and ancillary facilities. Extracted bitumen would be upgraded onsite; the lighter syncrude would be shipped to market, and the heavier materials would be used as fuel to produce steam for the steam drive extraction process.

PHASE I

Phase I activities are exploratory. Two coreholes would be drilled (in 1984) to obtain detailed information on bitumen quality and reservoir properties. The applicants propose to drill the two coreholes in the Gordon Flats area (see figure 5 in the "Alternatives Including the Proposed Action" section) and to use these two new test holes in conjunction with two existing coreholes to investigate natural and induced formation conductivity.

Access to the drill sites would be via the existing Flint Trail. No new permanent roads are proposed. Some leveling could be required from Flint Trail to the proposed drill sites, which are about 300 and 1,000 feet, respectively, from the Flint Trail. Air drilling equipment would be transported and set up onsite using trailer-mounted rigs. Two to five truck trips (averaging 25,000 pounds per load) would be required for set-up, and another two to five trips for demobilization. An average of two trips per day via small truck or automobile would be required for drilling crew personnel. The existing unimproved airstrip at Gordon Flats would be used by light planes (two or three trips a day for 10 days).

Each drilling pad would require a 200 x 200 foot cleared and leveled area and would include a 20 x 50 x 10 foot deep pit for disposal of drill cuttings. Air drilling methods would be used, and it is expected that no significant amounts of formation water would be produced. Each well would be cased from the surface to the top of the White Rim sandstone (the tar-bearing formation). Wellbore tests would include four types of electric logging to obtain rock and fluid saturation data and pump tests using air, inert gas, or fluids to determine horizontal and vertical communication across the tar zone. Inducing horizontal fracturing between the wells may also be attempted. The tests would be performed using truck-mounted equipment requiring no additional site preparation. Drilling set-up, testing, and demobilization are expected to take 15 working days and would require up to seven persons to perform drilling, supervisory, and testing operations.

No permanent facilities would be built onsite. Temporary onsite equipment would include the drilling rig, an instrumentation trailer or truck, a trailer

for administrative use, a 210-barrel water tank, pipe racks, a cement truck for installing casing, a chemical toilet, vehicles, and miscellaneous equipment such as trash containers. All solid and sanitary wastes generated during drilling and testing operations would be hauled offsite and disposed of at an approved landfill. Drilling cuttings, any produced waters, and other inert substances would be disposed of by burying in the disposal pit. The drill pads and any other disturbed areas would be reclaimed as specified by the surface managing agency (either the NPS or the BLM, depending upon exact corehole locations) after drilling operations are completed.

PHASE II

Phase II (1985 and 1986) would be designed to better delineate the tar sand reserves within the proposed federal lease unit. Up to 15 coreholes would be drilled and tested to determine the thickness and location of potentially recoverable bitumen (see figure 6 in the "Alternatives" section). Cores would be removed and tested for porosity, permeability, and saturation.

Primary access to the drill sites would be via the existing Flint Trail. An estimated 12 miles of new access trails would be required from Flint Trail to the individual drill sites. The roads would be temporary 12-foot-wide leveled trails. As currently proposed by the applicants, approximately 5.5 miles of new road would be within Glen Canyon National Recreation Area and 6.5 miles would be within the French Spring/Happy Canyon WSA. Approximately 54 miles of existing roads and trails (including Flint Trail) would be used within the proposed federal lease unit; approximately 4 miles of existing road or trail is within the French Spring/Happy Canyon WSA. Air drilling equipment would be transported and set up onsite at each of the 15 proposed drilling locations; equipment would be trailer-mounted rigs. Two to five truck trips (averaging 25,000 pounds per load) would be required for set-up at each of the 15 proposed drilling locations, and another two to five trips would be required for demobilization. An average of two trips per day via small truck or automobile would be required for drilling crew personnel. The existing unimproved airstrips in the area (such as those at Gordon Flats and Twin Corral Flats) would be used by light planes (two or three trips a day) during drilling operations.

Each drilling pad would require a 200 x 200 foot cleared and leveled area and would include a 20 x 50 x 10 foot deep pit for disposal of drill cuttings. Air drilling methods would be used, and it is expected that no significant amounts of formation water would be produced. Wellbores showing commercial quantities of bitumen would be cased and temporarily closed using a surface valve. Each of these wells would be cased from the ground surface to the top of the White Rim sandstone (the tar-bearing formation). Any wells not showing commercial quantities of tar would be permanently abandoned, with 100-foot cement plugs set from the top of the White Rim sandstone to the ground surface. Wellbore tests would include four types of electric logging to obtain rock and fluid saturation data and could include pump tests using air, inert gas, or fluids to determine horizontal and vertical communication across the tar zone. The tests would be performed using truck-mounted equipment requiring no additional site preparation. Drilling set-up, testing, and demobilization are expected to take 15 working days at each site and would require up to seven persons at each site to perform drilling, supervisory, and testing operations.

No permanent facilities would be built onsite. Temporary onsite equipment would include the drilling rig, an instrumentation truck or trailer, a trailer for administrative use, a 210-barrel water tank, pipe racks, a cement truck for installing casing, a chemical toilet, vehicles, and miscellaneous equipment such as trash containers. All solid and sanitary wastes generated during drilling and testing operations would be hauled offsite and disposed of at an approved landfill. Drilling cuttings, any produced waters, and inert substances would be disposed of by burying in the disposal pit. The drill pads and any other disturbed areas would be reclaimed as specified by the surface managing agency (either the NPS or the BLM, depending upon exact corehole locations) after drilling operations are completed.

PHASE III

Phase III would be a pilot-scale extraction project (in 1986, 1987, and 1988) to test extraction and upgrading feasibility and technology. The phase III pilot project would be located in the Gordon Flats area, in the vicinity of the phase I activities. Phase III would require drilling of two adjacent inverted five-spot well patterns (see figure 49). Each inverted five-spot has one central steam injection well and four production wells; the central steam injection well is used to increase formation temperature and pressure to induce the bitumen to flow into the production wells, where it can be pumped to the surface (see figure 50). In-situ processes are of three general types: (1) thermal processes that reduce the viscosity of the bitumen in the sandstone matrix primarily through heating; (2) chemical processes that flush the bitumen from the rock through the use of a solvent or chemically active solution; and (3) combinations of chemical and thermal processes. The process tentatively identified for pilot-scale testing is a steam-drive (thermal) process, but other types of in-situ recovery may also be tested as a part of phase III. Bitumen extraction during phase III is expected to average about 180 to 200 bpd and would not exceed 500 bpd. No upgrading would be performed onsite.

Equipment used onsite during phase III activities would include conventional production equipment plus onsite steam generators, electrical generators, water pumps, storage and softening equipment, piping, control equipment, and instrumentation. No permanent buildings would be constructed, but one or more trailers would be required to house instrumentation, administrative functions, and worker facilities such as toilets and work/eating areas. An estimated 20 to 50 workers would be onsite during various stages of construction, and 7 workers would be required to operate and monitor equipment during the operational phase (with additional workers onsite as necessary to conduct special testing programs).

The proposed phase III pilot facilities site is relatively flat and is accessible via the existing Flint Trail and the Gordon Flats airstrip. Access to the facility from Flint Trail would either be via one of the trails developed during phase I or II or would be a new short access road constructed under phase III, depending upon the exact location and configuration of the facilities. The Flint Trail could required widening and improvements (including culverting and paving) during phase III. If the Gordon Flats airstrip is used

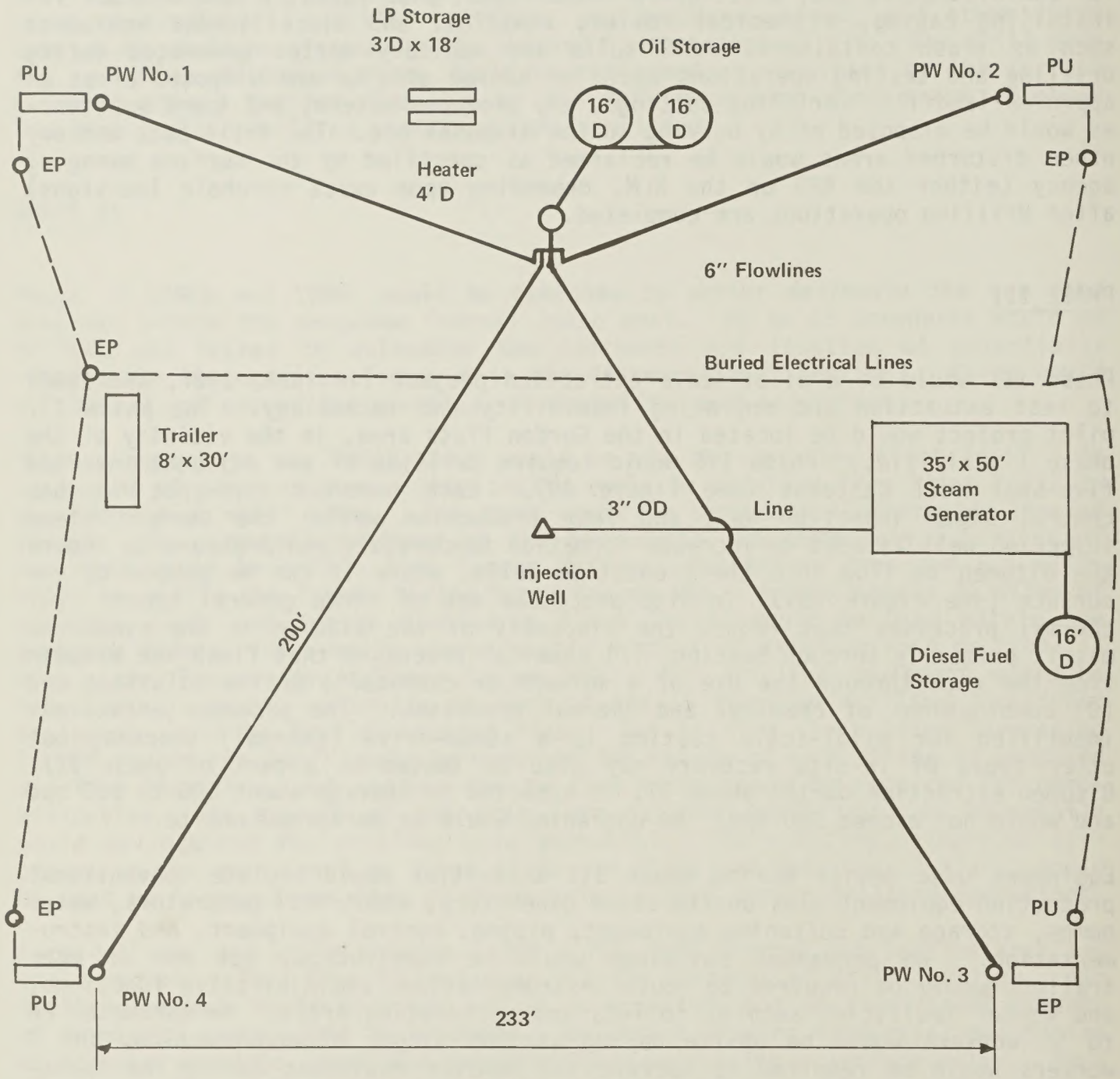


Fig. 49. Phase III Plan View, Typical Five-Spot Layout

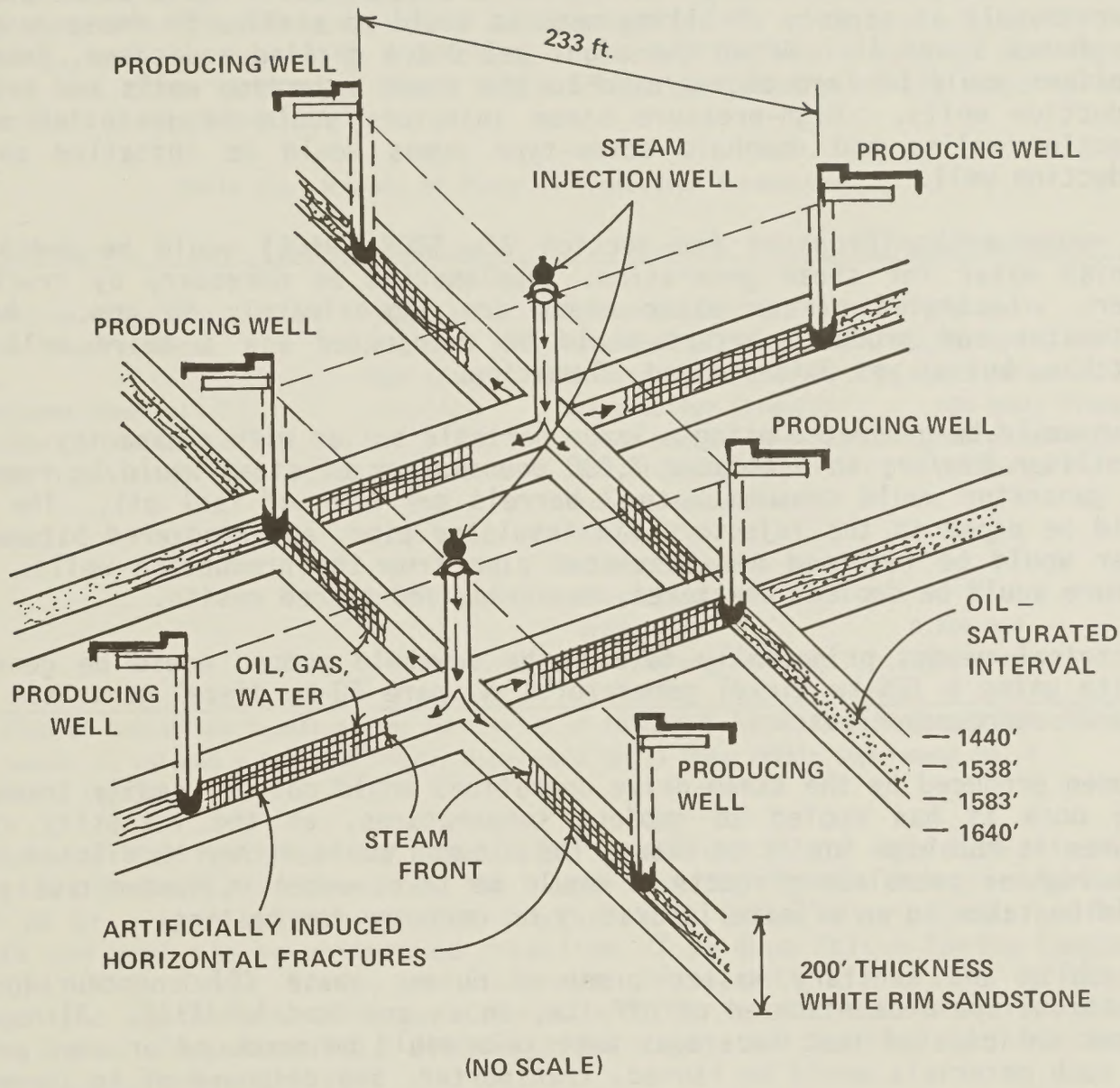


Fig. 50. Phase III Double Five-Spot Isometric

regularly, it would also require some upgrading and drainage improvements (there currently is a stockwatering pond on the airstrip).

The planned spacing of wells within the adjacent five-spots is 200 feet on centers between injection and production wells, and 233 feet on centers between production wells. Drilling would require leveling and clearing of approximately 8 acres within the extraction zone, with additional clearing and leveling for road access and ancillary facilities (estimated total disturbance would be approximately 15 acres). Drilling methods would be similar to those described for phases I and II. After the eight wells are drilled and cased, insulated pipelines would be laid aboveground to the steam injection wells and from the production wells. High-pressure steam injectors would be installed on the injection wells, and downhole screw-type pumps would be installed on each production well.

Two water wells (proposed for section 22, T30S, R16E) would be drilled to furnish water for steam generation, supplemented as necessary by trucked-in water. Estimated makeup water needs are approximately 60 gpm. Process wastewater and produced waters would be reinjected via a third well to a suitable, but as yet unidentified, formation.

Steam would be generated using a large portable boiler with a capacity of 10 to 15 million Btu/hr; an estimated 7,000 pounds/hour of steam would be required. The generator would consume 2 to 3 barrels per hour of fuel oil. The steam would be piped to the injectors via insulated pipe, and recovered bitumen and water would be returned via insulated pipe from the production wells. This mixture would be cooled, dewatered, measured, and stored onsite.

Electrical needs, principally to run the downhole pumps, would be generated onsite using a 125-kw diesel generator. A spare 50-kw diesel generator would provide emergency electrical power.

Bitumen produced by the steam-drive operations would not be readily transportable once it has cooled to ambient temperatures, as the viscosity of the bitumen is too high for it to flow. The bitumen would either be diluted onsite with lighter petroleum products or would be transported in heated trucks. It would be taken to an offsite laboratory or refinery for testing.

All solid and sanitary wastes produced during phase III construction and operations would be disposed of offsite, in an approved landfill. Although it is not anticipated that hazardous materials would be produced or used onsite, any such materials would be stored, transported, and disposed of in accordance with regulations and at a disposal site approved for such purposes.

After pilot-scale operations are completed, the facility would be dismantled, the wells would be plugged as described for phase II operations, and all equipment would be removed from the site. Depending upon whether the same areas would be used for phase IV activities, the area would either be reused during phase IV or would be reclaimed as specified by the surface managing agency.

PHASE IV

Phase IV would be full-scale commercial development (construction commencing in 1990). The entire lease unit would be developed through in-situ steam-drive extraction. The extraction activities would move over time through 18 prospective areas (extraction zones). Each prospective area would be developed to produce bitumen at a rate of 30,000 bpd. The extracted bitumen would be upgraded onsite in a refinery-type facility, using a delayed coking process. Upgraded syncrude (20,700 bpd) would be transported to market via pipeline or by trucking, and the remaining 9,300 bpd of production would be used for steam generation and other processes (see table 55 for a summary of the major phase IV production assumptions).

Table 55: Summary of Phase IV Production Assumptions

Raw Materials	Project Inputs	Products	Project Outputs
Steam injection wells	940 wells	Production wells	1,000 wells
Makeup water requirements	1,050 gpm	Recovered bitumen	30,000 bpd
Limestone	600 T/day	Recovered water	2,880 gal/min
Water treatment chemicals	133 T/day	Waste sulfur (liquid)	100 short T/day
Extraction and process steam (saturated; 1,575 psig)	2,270,000 lb/hr	Boiler waste (dry)	800 cu yd/day
		Silt disposal (dry)	170 cu yd/day
		Process wastewater disposal	150 gpm
		Bitumen expended in extraction and processing	9,300 bpd
		Net syncrude produced	20,700 bpd

Source: Plan of Operations Submitted for Conversion of Oil and Gas Leases to Combined Hydrocarbon Leases (3 volumes - December 1982); Supplement No. 1 (May 1983); Supplement No. 2 (July 1983).

Access to the initial phase IV activities at Gordon Flats would be via the existing Flint Trail, either from the north via the Temple Junction turnoff from UT 24 or via an unimproved road south out of Green River, Utah; or from the south and west via an unimproved road from UT 95 down Poison Spring Canyon, across the Dirty Devil River, and into the lease unit via trails up Hatch Canyon or the South Fork of Happy Canyon. Either route would require major upgrading, including crowning, ditching, drainage, and paving, and possibly bridging of major watercourses.

The initial prospective area #1 would be developed as a single construction project; the wellfield of 1,000 production and 940 steam injection wells would be drilled over an 18-month period beginning in 1990. The upgrading facilities and steam generation facilities, plus other ancillary facilities, would be constructed at Gordon Flats (see figure 7 in the "Alternatives" section for the wellfield layout for prospective area #1; figure 51 for the upgrading and steam production facilities; and figure 52 for an elevation view of the facilities). These facilities would be operational by 1994. Peak manpower requirements

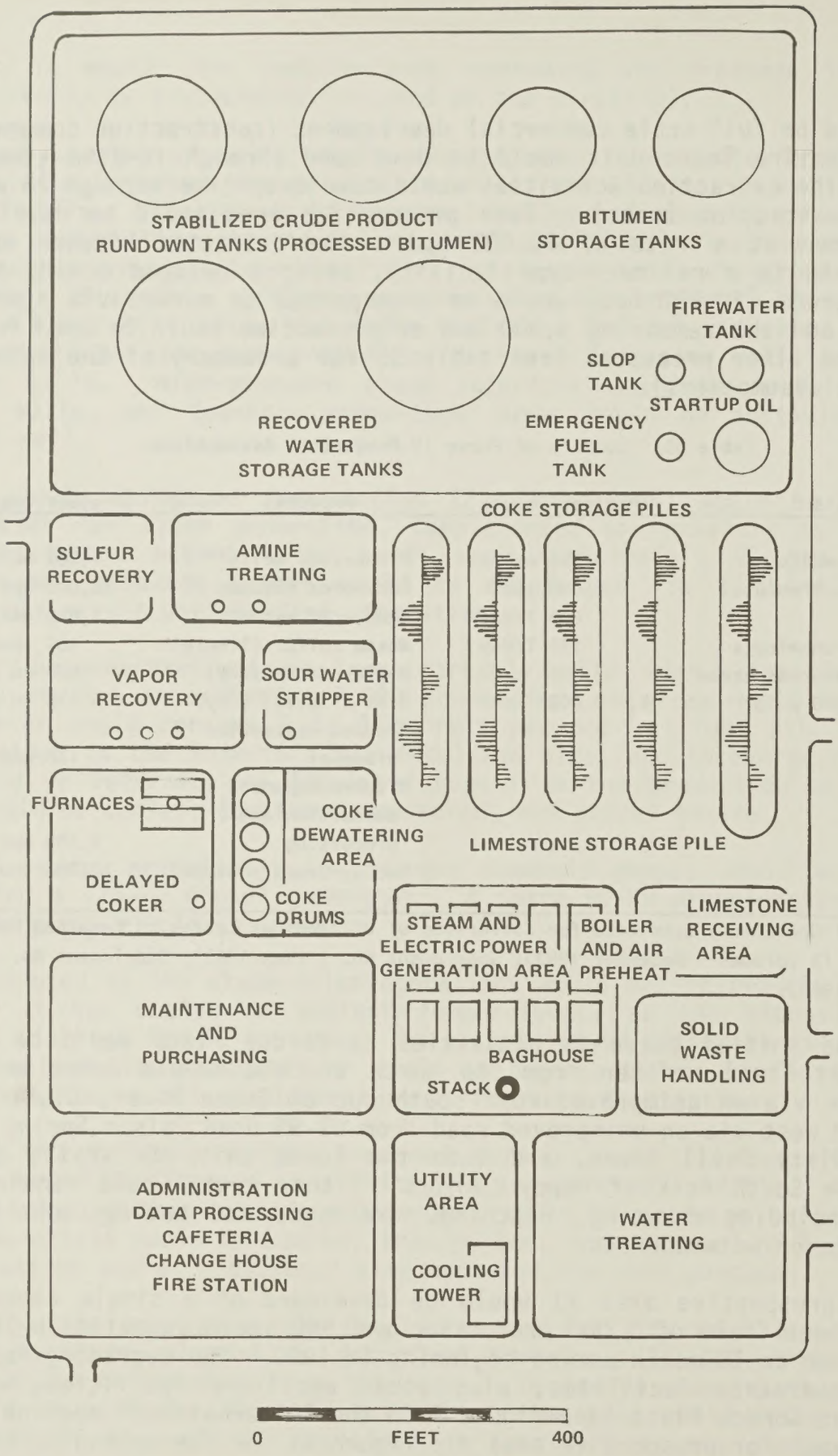
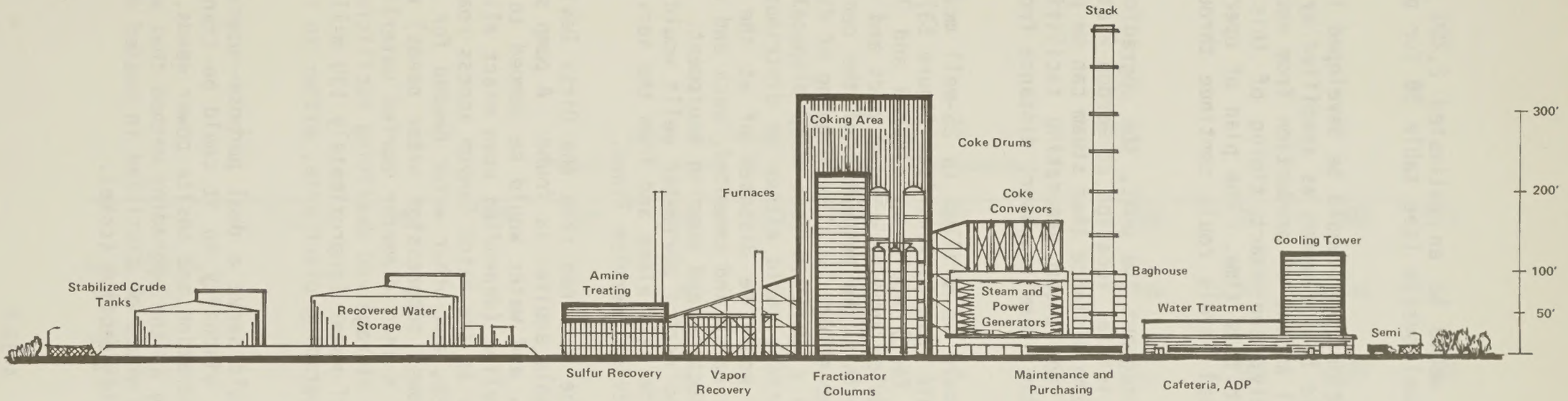


Fig. 51. Phase IV Plan View, Upgrading and Steam Generation Facilities



NOTE: Artist's conception from information provided in the Plan of Operations.

0 50 100 200 300 Feet

Fig. 52. Elevation — Phase IV Facilities

would occur in 1994, when there would be an estimated 2,200 construction workers and 200 operational personnel onsite (see table 56 for project workforce estimates).

As bitumen is depleted, new extraction zones would be developed in a progressive fashion. Depleted areas would be reclaimed as specified by the surface managing agency. Because the total amount of production from each extraction area cannot be estimated accurately, the exact timing of this progressive development cannot be identified at this time. The plan of operations indicates that development at commercial levels could continue through the year 2205.

As wellfield development moves throughout the unit, the upgrading facilities would continue to operate at their initial location at Gordon Flats. However, since there are physical limits on the distance that steam can be piped without excessive heat and pressure loss, the steam generating facilities would be moved over time so as to minimize the steam transport distance from generating facility to injectors.

The extraction zone (wellfield) would be drilled in 25-well modules to the maximum extent possible given terrain restrictions (see figure 53). A central wellpad (approximately 250 x 250 feet) would be cleared and leveled as a staging area for drilling each module; smaller cleared pads and set-up areas would be required for wells not within the perimeter of the central cleared area. In areas where soils are deep enough to allow digging of disposal pits, cuttings would be blown into a 20 x 50 x 10 foot deep disposal pit in the central pad. In other areas, cuttings would either be distributed over the wellpads and surrounding areas or would be disposed of at the solid waste disposal site. Each well would be cased and cemented, each and would have a small concrete pad for setting injection and pumping equipment. The central pads would be served by blacktopped roads; perimeter wells would be serviced from dirt roads. Pipe runs would be laid along and from the service roads to individual wellheads, as would electrical service lines.

Water for steam generation would be obtained from the Dirty Devil River and perhaps from local wells if a suitable aquifer is found. A pump station would be built on the Dirty Devil River, and water would be pumped to the project site via a 12- to 15-mile-long pipeline (depending upon exact alignment) that would follow roughly the same route as the Hatch Canyon access road. Approximately 1,050 gpm extraction, process, and other water needed for plant operation (exclusive of irrigation or dust suppression water needs) would be required. The applicants propose a 4-inch diameter buried waterline from the river to the plant site, with water storage and desilting facilities located at the plant site. A 90-day supply of water (approximately 130 million gallons) would be stored near the 40-acre upgrading plant site, either in tankage or in a lined, covered storage reservoir.

The onsite upgrading facilities would serve a dual purpose--upgrading of the bitumen sufficiently to reduce its viscosity so it could be transported, and producing fuel (coke) for steam generation and onsite power needs. The applicants have identified delayed coking as the upgrading method that would be used for commercial operations. Bitumen would be distilled in heated drums, yielding a lighter oil product and a solid fraction (coke).

Table 56: Workforce Estimates
Phases I - III and Initial Phase IV Development

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Construction Personnel	-	-	-	-	20	50	100	140	500	2,000	2,200	1,000	-
Operation Personnel	-	-	-	-	7	7	-	-	-	-	200	350	350
Total	0	0	0	0	27	57	100	140	500	2,000	2,400	1,350	350

Note: As commercial development progresses and moves throughout the proposed federal lease unit over time, cycles of construction would recur. This table represents construction and operational workforce estimates for phases I through III and through construction required for the initial development of the first of the 18 prospective areas within the proposed federal lease unit.

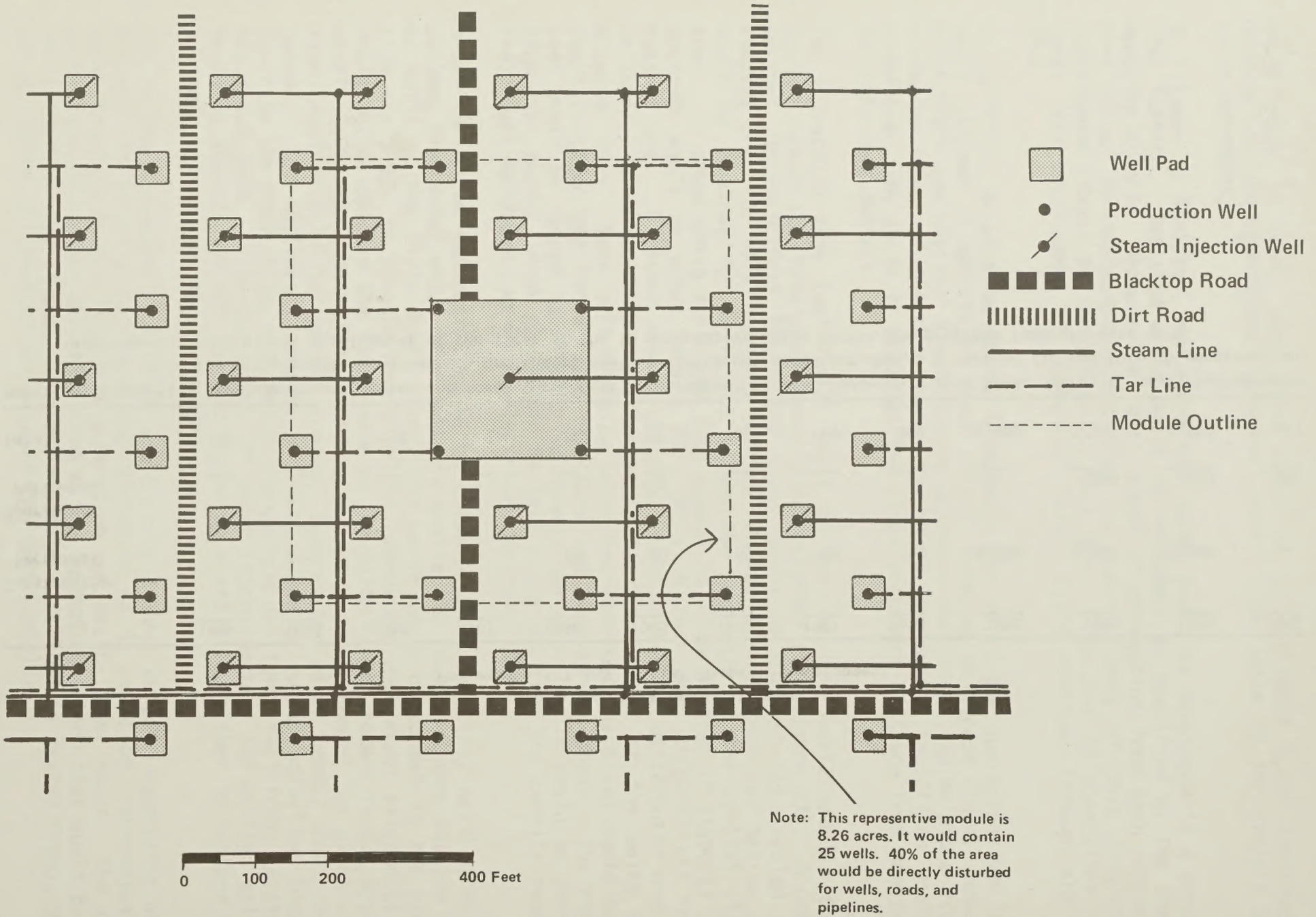


Fig. 53. Phase IV Schematic Representation of Typical 25-Well Module

Approximately 30,000 bpd of extracted bitumen and 2,880 gpm of recovered water would be pumped from the extraction zone to the upgrading facilities. Oil would be removed from the extraction water stream by the oily water separators and would be stored in bitumen storage tanks. Bitumen would be pumped from the storage tanks to the delayed coking unit, where it would be heated and would enter the coker fractionating tower. The more volatile portion of the bitumen would be vaporized and would join the rising coke drum vapors. The remaining heavier part of the bitumen and the heaviest portion of the coke drum vapors would condense and be pumped from the bottom of the fractionator to the furnace, where it would be heated. The heated mixture would enter the coke drums, where coke is formed. The vapors would be drawn off the coke drums and pumped back to the fractionator. The combined coke drum vapors and the more volatile bitumen vapors would then be separated by distillation in the upper section of the fractionator. When each drum is filled, it would be taken out of service, and the coke would be removed from the filled drums by water cutting. The water would be retained in a closed system, and the drained coke would then be transported by belt conveyor to a storage and reclaiming area (30-day coke storage capacity). The coke would be transported as needed from the storage area to the fluidized bed combustion units, where it would be used as fuel for steam generation.

In the fractionator, gasoline and gaseous products of the coking operation would pass out of the top of the unit; the gas would be compressed, and the gasoline would be pumped to the vapor recovery unit. The heavier hydrocarbons would be condensed so that only the noncondensable gases and some propanes and butanes remain in the gas. Most of the propanes and butanes and all the heavier hydrocarbons would be recovered as a liquid and delivered to syncrude tankage. A diesel fuel oil boiling range material and a gas oil would be produced as side product from the fractionator and normally would also be delivered to syncrude tankage.

The gaseous product from the vapor recovery unit would be treated in the amine unit to remove hydrogen sulfide. Part of the sulfur-free recovered fuel gas would be burned in the coker feed heater, and any excess fuel gas would be burned in the fluidized bed combustion unit. Coker fired-heater fuel gas would be released to the atmosphere.

Hydrogen sulfide removed from the fuel gas in the amine unit would be combined with the hydrogen sulfide and ammonia stream stripped in the sour water stripper and with any vapors from the oily water separators. These combined gases would be fed to the sulfur recovery plant, where elemental sulfur (100 short tons per day) would be produced. The liquid sulfur would be trucked offsite for disposal or to market, and the sulfur plant tail gas would be delivered to the fluidized bed combustion units for capture of any residual sulfur content.

Raw water would be pumped from water storage to the water treatment plant, where boiler feedwater, potable water, and utility water streams would be produced. The water treatment plant would also treat the returned condensed injection steam for reuse. Both raw and recovered water would contain suspended and dissolved materials that must be removed, as well as free and dissolved oil. The major functions of the water treatment subunits would be filtration to remove suspended solids; softening to remove calcium and magnesium salts; activated carbon treatment to remove organics; demineralization to remove dissolved solids (including silica); and chlorination for biological control.

To conserve water, dissolved solids would be further concentrated in the aqueous waste stream through evaporation. The final wastewater stream (approximately 100 gpm) would be disposed of by injection into a suitable, but as yet unidentified, underground formation through a deep well.

Water would be used to generate high-pressure steam required for bitumen extraction and electrical power generation. The total plant steam requirement (up to 2.27 million pounds/hour) would be generated in five fluidized bed combustion units through combustion of coke and fuel gas produced in the delayed coking unit.

Coke would be conveyed from one of the storage piles to a crusher, where it would be crushed to a size suitable for boiler feed. The sized coke would then be conveyed via covered conveyor to a storage hopper at each boiler, where it would flow into the fluidized bed at the base of the boiler by gravity. As the boilers are moved during the life of the project, conveyors or trucks would be required to transport coke from the upgrading facility to the combustion units. Limestone would also be delivered to the site by truck and would be crushed and conveyed to hoppers at each combustion unit, where it is fed in by gravity.

In the fluidized bed combustion units, the coke would be burned in a bed held in suspension by the entering combustion air. The very turbulent conditions cause the outer surface of the coke particles to continuously erode, exposing a new surface for combustion and allowing high thermal efficiencies without the need for pulverizing the coke. Sulfur in the coke is converted to sulfur oxides during the combustion process and would react with the limestone to form calcium sulfate (gypsum); therefore, a separate flue gas desulfurization unit would not be required. The gypsum and fly ash particles produced in the combustion unit form the boiler solid waste (800 cubic yards per day), which must be removed and disposed of.

The treated water would be fed into the combustion units through overhead tubes above the fluidized bed, and heated to form high-pressure steam. Steam used for electrical power generation would be superheated by rerouting it through tubes within the fluidized bed. Steam required for bitumen extraction would be sent from the overhead tubes to the injection wells. The superheated steam for power generation would be expanded in separate steam turbines to drive electrical power generators (approximately 32-megawatt capacity) for pump operation and other facility electrical needs.

Particulates carried overhead from the fluidized bed would be captured in cyclones and recycled to the combustion unit. Flue gases leaving the cyclones would be used to preheat boiler feedwater, and then would enter the baghouse, where final particulate removal would take place. The flue gases from the five combustion units would be combined and directed to a common stack, where they would be released to the atmosphere.

Fire protection for the plant facilities would be provided by water supplied to a four-hour capacity dedicated fire water storage tank. The raw water transfer pumps (1,050 gpm, 100 percent spare) would deliver water from the raw water reservoir or tanks to the fire water tank, and two 100-percent capacity, 2,500 gpm fire water pumps (one electric and one diesel) would transfer water to the fire water loop and hydrants. A 125-gpm jockey pump would maintain the fire water loop pressure at 125 psig.

Equipment in the bitumen processing plant would be protected from overpressure and possible explosion by pressure safety relief valves sized to pass the maximum possible flow safely. Nonhazardous streams (nitrogen, air, cooling water) would be exhausted to the atmosphere if pressure relief becomes necessary. Hazardous or flammable streams would be vented to a closed flare system, where they would be incinerated before release to the atmosphere.

Solid waste from the plant site would include boiler waste, treated sanitary wastes, silt, water treatment plant wastes, and storage tank bottoms. Water treatment waste would be disposed of in the wastewater injection well. Tank bottom wastes would be graded into tank firewall embankments onsite. Digested sanitary wastes would be used for reclamation. Boiler waste would require disposal in a landfill. A specific disposal site has not been identified, but use of gullies or ravines within or near the lease unit has been proposed. Silt would be disposed of in a similar fashion to boiler waste, but, as its characteristics would more closely resemble that of the native soils, it likely would not be transported offsite for disposal, but would be landfilled and reclaimed near the plant site.

The applicants have proposed no definite method or route for product transport from the project site to market; trucking and pipeline transport have been suggested as possible methods, with pipelining the most probable method at phase IV. No definite pipeline routing or alignment has been specified, but two possible routes have been suggested: (1) south from the proposed federal lease unit, across Andy Miller Flats to southwest of Mills Crag Bend, then east across the Colorado River at Narrows Canyon to connect with an existing oil pipeline east of Glen Canyon National Recreation Area; or (2) north out of the unit to a point north of Canyonlands National Park, then east across the Green and Colorado rivers, to a point east of the park, then slightly south to connect with an existing oil pipeline.

As previously discussed, extraction areas would be reclaimed in progressive fashion as each area is exhausted. The central plant facilities in the Gordon Flats area would be removed (as would the relocated steam plants), and the site (including roads, pipeline rights-of-way, and waste disposal areas) would be reclaimed to the surface managing agency's specifications once the entire project is completed.

APPENDIX B: STATE-OF-THE-ART EXTRACTION AND UPGRADING TECHNOLOGIES

TAR SAND EXTRACTION

This section discusses state-of-the-art tar sands technologies and briefly compares these technologies to the steam drive tar bitumen production process proposed by the applicants as outlined in appendix A.

The plan of operations proposes an in-situ steam-drive process. Alternative extraction methods used in the industry include the following:

Open-pit mining for recovery of resource or bulk sampling (This method includes the removal of any overburden that overlies the resource and then the extraction of the resource. The surface is then reclaimed to the desired contours and revegetated.)

Underground mining, including access through slopes, shafts, or adits (tunnels) to the mining areas (Recovery of the resource may be by extraction of the raw oil-impregnated sandstone for surface processing or by underground in-situ methods that would extract the tar bitumen from the sandstone, leaving the sandstone in place.)

A combination of mining and in-situ methods

There are nearly 1,300 feet of overburden over most of the tar sand resource in the Tar Sand Triangle deposit. Economics would preclude open-pit mining of the deeply buried resource; however, the tar sand resource in the valley bottoms may be accessible by open-pit mining.

Underground mining methods have been proposed that might be available for the Tar Sand Triangle resource (Piper, Riddell, and Trent 1983). However, any mining operation is likely to be very expensive because of the relatively thin tar sand seam at the Tar Sand Triangle.

The United States currently has little commercial oil production from tar sand. However, in-situ steam and combustion technologies (proven successful for heavy oils), various mining and plant extractions, and modified in-situ processes could lead to significant future production from tar sand (Marchant and Terry 1982). Continued research and field testing of tar sand projects are providing a base of knowledge and experience for economic exploitation of this energy resource.

The primary technical deterrent to production of oil from tar sand using in-situ processes is the high viscosity and resultant immobility of the oil. In-situ processes generally reduce viscosity using thermal processes (steam or combustion).

Steam projects often use steam flood preceded by or in conjunction with cyclic steam injection. Unique steam processes include combinations of steam and combustion, coinjection with sodium hydroxide and carbon dioxide, and coal-fired fluidized bed combustors for steam generation. Conoco and Enpex projects in the Saner Ranch field in Texas include present and planned use of coal-fired fluidized bed combustors to generate steam. The Conoco project uses a patented fracture-assisted steam technology (FAST) process. At the Kirkwood project in Wyoming's Burn Hollow tar sand deposit, sodium hydroxide is added to enhance

the steam-drive process. The Signal Oil and Gas Company tests in Utah's Sunnyside deposit were conducted in horizontal wells drilled in a quarry face.

In-situ combustion processes (also known as "fireflood") include forward and reverse combustion. When the combustion front moves in the same direction as the air supply, the process is called forward combustion, and when the air moves in the opposite direction of the movement of the combustion front, the process is called reverse combustion. Several combinations and variations of the forward and reverse combustion can be applied within a single project.

The Laramie Energy Technology Center conducted a series of experiments including reverse combustion, combination reverse and forward combustion, and steam flood. The center currently has a planned combination reverse combustion and steam-drive experiment on the drawing board.

Radio frequency heating for production from tar sand deposits is in the early stages of development. The Illinois Institute of Technology Research conducted a small-scale field experiment to test feasibility of the radio frequency heating of tar sand.

Modified in-situ tar sand processes have been proposed by several companies. The Cornell Heavy Oil Process Company's is a horizontal in-situ process using injection wells drilled from an underground cavern. A large diameter cased well is used for access to and development of the cavern. The production wells also serve as steam injection wells during the reservoir preheating phase. After preheating, vertical wells drilled from the surface serve as steam injection wells, and the horizontal wells become production wells.

The California Tar Sand Development Corporation will use downhole hydraulic mining. A surface plant will separate the tar from the sand.

The EOR Petroleum Companys' plant in Labette County, Kansas, employs the "flip-flop" process developed by Tetra Systems, Inc. The top of the deposit accessed by a mine shaft and tunnels is heated by a surfactant solution, and the displaced oil is skimmed off the top of the reservoir and pumped to the surface.

Nearly all tar sand projects include plans for some form of product upgrading before refining. Upgrading may be simple dilution with conventional crude oils or more vigorous hydrogenation at high temperature and pressure.

In-situ combustion processes (fireflood, either forward or reverse combustion, and combinations of steam flood and combustion) of part of the resource provide heat to mobilize the oil or tar bitumen. Few control parameters are available for in-situ combustion processes. By contrast, many parameters can usually be varied in surface processes to control the process. Process upset conditions will occur more often in combustion processes because of the lack of control parameters. Partial combustion of organic constituents may leave unwanted or undesirable materials in the underground formation. Inefficient combustion of the in-place resource will alter emissions from the process.

The steam flood process differs from other in-situ combustion processes because thermal energy to mobilize the tar bitumen is derived from a surface steam plant. No underground combustion occurs, and there is comparatively little

alteration of the underground formation. The process is less efficient than surface processes, but may be easier to control than underground combustion processes. The anticipated air emissions and groundwater effects of an in-situ combustion and steam-drive process would be quite different.

APPENDIX C: GENERAL RESTRICTIONS

INTRODUCTION

As a condition of granting any lease conversions or other authorizations, the various agencies require that certain general terms and conditions be met. The federal government has mandates to protect: threatened and endangered species and their critical habitat; historical, archeological, and paleontological resources; recreation values; wilderness values; and wild horses and burros.

In addition to authorities provided in the organic acts of the surface managing agencies and in the enabling legislation for Glen Canyon National Recreation Area and Canyonlands National Park, authority for mitigation of loss of vegetation, livestock forage, wildlife habitat, archeological and paleontological values and a reduction in water and air quality, aesthetic values, and recreation on federal lands is granted under the following major legislative mandates:

Preservation of American Antiquities Act of 1906
Wilderness Act of 1964
National Historic Preservation Act of 1966
Executive Order 11593 of 1971 (Protection and Enhancement of the Cultural Environment)
Archeological and Historical Data Preservation Act of 1974
The Clean Air Act of 1977 (as amended)
The Federal Water Pollution Control Act (Clean Water Act) of 1977
Endangered Species Act of 1978 (as amended)
Executive Order 12088

Federal regulatory agencies also require compliance with safety and noise level regulations imposed by the Occupational Safety and Health Act of 1970; with the Federal Aviation Administration clearance standards, granted under authority of the Federal Aviation Act of 1958; and with grounding and clearance requirements of the National Electric Safety Code.

Because future conditions may result in project refinements or adjustments all mitigating measures outlined can be modified by the appropriate federal official.

Should future offlease rights-of-way be necessary on federal lands, further environmental analysis must be conducted prior to any future right-of-way grant.

Prior to commencing any ground-disturbing activities, the applicants are required to submit an operating plan in accordance with 30 CFR §§221 and 231, covering, at a minimum:

fire protection plan
clearing - visual resources mitigation
erosion control, revegetation, and restoration
communications
cultural resources surveys and mitigation plan

threatened and endangered studies and mitigation (include a wildlife mitigation plan developed jointly by Utah Division of Wildlife Resources (UDWR), Bureau of Land Management (BLM), National Park Service (NPS), and the applicants)
blasting
pesticide and herbicide use
health and safety
    solid waste disposal
    emergency response
    air quality
    transportation and access plan
    hazardous waste containment and disposal
    spill containment plan
site prescription
right-of-way maintenance and monitoring

Technical assistance and approval of written plans for federal lands may be obtained from the surface managing agency (BLM or NPS) before commencing any construction.

Under authority of section 504 of the Federal Land Policy and Management Act (FLPMA), the applicants are required to provide funding to the appropriate federal agencies for the purpose of financing one or more specialists for administration of construction activities.

BLM RESTRICTIONS

The following list of standard restrictions are typical and would be refined by the agencies before any lease is granted or any activity is authorized.

GENERAL

1. All state and federal regulations and laws must be complied with.

2. All activities associated with the projects must be conducted in a manner that will avoid or minimize degradation of air, land, and water quality. In the construction, operation, maintenance, and abandonment of the projects, activities must be performed in accordance with applicable air and water quality standards, and related plans of implementation, including but not limited to, the Clean Air Act, as amended (42 USC 1321) and the Clean Water Act (USCA 1251).

3. Permittees and other regular users of public lands affected by construction of the projects must be notified in advance of any construction activity that may affect their businesses or operations. This will include, but not be limited to, signing of temporary road closures, notification of proposed removal or cutting of fences, and disturbances to range improvements or other use-related structures.

TRANSPORTATION

1. A transportation plan must be submitted, covering approval of temporary, reconstructed, and newly constructed roads and will include clearing work, signing, rehabilitation, and uses associated with transportation needs. Overland or air access may be specified in lieu of road construction or reconstruction.

2. Access roads necessary for operation and maintenance of the projects must be clearly identified. Some of these access roads may be designated by the authorizing agency as open for public use, including but not limited to, offroad vehicular (ORV) travel.

3. Helicopters must be used to string pipe and deliver equipment in areas where access due to the terrain or management constraints preclude standard access construction.

4. Portions of the lease conversion and other areas where use by the applicant is authorized may be used for access only when necessary and only during the construction period. The temporary access roads will be closed and vegetative cover reestablished after construction is completed.

5. The applicants must control ORV use within the lease conversion areas. Such specified control could include use of physical barriers, replanting trees, or other reasonable means of ORV control.

LAND USE

1. Disturbance of improvements such as fences, roads, and watering facilities during the construction, operation, and maintenance must be kept to an absolute minimum. Immediate restoration of improvements to at least their former state will be required. Functional use of these improvements must be maintained at all times. When necessary to pass through a fence line, the fence should be braced on both sides of the passageway prior to cutting the fence. A gate acceptable to the authorizing agency official should be installed in any gate opening and kept closed when not in actual use. Where a permanent road is to be constructed or maintained, cattleguards should be placed at all fence crossings.

2. If a natural barrier used for livestock control is broken during construction, the applicants must adequately fence the area to prevent drift of livestock. Fence specifications will be determined on a case-by-case basis.

WATER

1. All river, stream, and wash crossings required for access to project facilities must be at existing roads or bridges, except at locations designated by the authorizing agency official. Culverts or bridges must be installed at points where new permanent access roads cross live streams or washes. Where temporary roads cross drainages or dirt fills, culverts will be installed and removed upon completion of the project. Any construction activity in a perennial stream is prohibited unless specifically allowed by the authorizing agency official. All stream channels and washes will be returned to their natural state once operations are complete.

2. Construction plans for crossing streams by boring, driving, or trenching must be approved by the authorizing officer.

3. A buffer strip of terrestrial vegetation above the high water line must be left between work areas adjacent to the stream.

4. In streams, construction must be planned to coincide with low water flows.

5. The applicants must complete the work and return the the stream to its natural state as soon as possible.

6. Stream banks must be returned, as nearly as possible, to their original condition.

7. Backfill material for the pipe in the streambed must be of predominantly coarse material.

WASTE

1. Construction equipment must be refueled and maintained outside stream channels or washes in areas designated by the authorizing agency official.

2. Garbage and other refuse must be disposed in an authorized disposal site or landfill. Engine oil changed on federal lands will be contained in suitable containers and disposed of as refuse; no fuel, oil, or other hydrocarbon disposal is permitted. If a spill accidentally occurs, the authorizing officer must be notified immediately and corrective measures undertaken as directed.

3. Within 30 days after conclusion of construction and operation, all construction materials and related litter and debris must be disposed of in accordance with instructions of the authorizing officer.

VEGETATION

1. Vegetation cleared during construction, operation, maintenance, or other activity must be disposed of as directed by the authorizing officer.

2. Disturbed areas, which in the opinion of the authorizing agency are unsuitable for successful revegetation, must be protected under the reclamation, erosion control, and revegetation provisions of the plan. The plan should state the method of protection to be used and the provisions for prevention of site deterioration and erosion.

SOILS

1. Existing soils and geologic data must be gathered and used to achieve maximum revegetation and soil erosion mitigation responses.

2. Areas subject to mudflows, landslides, mudslides, avalanches, rock falls, and other types of mass movement must be avoided where practicable in locating linear facilities. Where such avoidance is not possible, the design, based on detailed field investigations and analysis, will provide measures to prevent the occurrence of mass movements.

3. All topsoil and suitable plant growth material on federal lands must be conserved for reclamation requirements; excess topsoil will be stockpiled at designated locations.

4. Trees and brush (indigenous species) must be established according to the revegetation, erosion control, and rehabilitation plan.

5. All disturbed areas must be landscaped and revegetated as nearly as possible to their original conditions or to a condition agreed on between the applicant and the authorizing officer. This reclamation will be

accomplished as soon as possible after the disturbance occurs. The authorizing officer will determine when revegetation can be determined completed.

6. In areas where soil surface has been modified or natural vegetation has been removed, noxious weeds must be controlled.

SCENIC RESOURCES

1. A plan to minimize visual impacts is required. For BLM lands, the applicants must design and locate the lease conversion elements to blend into the existing environment so as to most nearly meet the minimum degree of contrast acceptable for the visual resource management class in which the structures would be located, and for NPS lands, operational elements must be designed to cause the least possible intrusion in terms of form, size, and color. The authorizing agency will evaluate and approve measures before construction begins.

2. Edges of vegetative clearings must be feathered where feasible to avoid straight lines.

CULTURAL AND PALEONTOLOGICAL RESOURCES

1. All significant cultural resources identified in the project area must be avoided wherever possible. For significant cultural resources that cannot be avoided, a memorandum of agreement with the Advisory Council on Historic Preservation and the Utah State Historic Preservation Office must be developed that details specific mitigation measures in accordance with 36 CFR 800. All cultural resources discovered during construction that were not previously identified will be left undisturbed until they can be evaluated for significance and until appropriate mitigation can be specified.

2. The applicant must provide a qualified paleontologist who is approved by the authorizing officer. The paleontologist will conduct an intensive survey of all areas to be disturbed according to the significance and mitigation needs specified by the applicant. The paleontologist will be available, as needed, during surface disturbance. If in the opinion of the paleontologist, paleontological values specified by the applicant would be disturbed, construction will be halted until appropriate mitigation can be specified.

3. The applicant must control illicit disturbance or collection of cultural or paleontological resources by his employees by the most effective means available. Operations may be halted by the authorizing officer until the applicant demonstrates such control.

THREATENED AND ENDANGERED PLANT AND ANIMAL SPECIES

1. The applicant must conduct surveys to determine if listed threatened or endangered species or their critical habitats may be present. If it is determined that listed species or their habitats may be present and could be affected by the proposals, appropriate consultation with the U.S. Fish and Wildlife Service (FWS) must be conducted by the federal authorizing agency. No activities will be authorized until consultation is complete as specified by section 7(c) of the Endangered Species Act. The biological opinion issued by the FWS as a result of the consultation process will specify appropriate mitigation measures.

PESTICIDES

1. Applicable federal and state laws and regulations concerning the use of pesticides (i.e., insecticides, herbicides, fungicides, rodenticides, and other similar substances) must be complied with in all activities and operations. The applicant must obtain program approval from the authorizing agency prior to the use of such substances. The program request will provide the type and quantity of material to be used; the pest, insect, fungus, etc., to be controlled; the method of application; the location of storage and disposals of containers; and other information that may be required. The request must be submitted no later than December 1 of the calendar year prior to the start of the fiscal year when the activities are proposed (i.e., December 1, 1984 deadline for a fiscal year 1985 action). Emergency use of pesticides must be approved by the authorizing agency. A specific pesticide will not be used if the Secretary of the Interior or Agriculture has prohibited its use. A pesticide will only be used in accordance with its registered uses and with other secretarial limitations. Pesticides will not be permanently stored on federal lands.

CORPS OF ENGINEERS RESTRICTIONS

The Corps of Engineers (COE) has prescribed management practices that must be followed to the maximum extent practicable for discharges covered by the Nationwide Permit System (items 1 through 8 below). Additionally, certain conditions (33 CFR 323.4-3[b]) must be met under the nationwide permit authority items 9 through 17 below). (For further detail, please refer to the COE Permit Program "A Guide For Applicants," November 1, 1977.)

1. Discharges of dredged or fill material into U.S. waters must be avoided or minimized.

2. Discharges in spawning areas during spawning seasons must be avoided.

3. Discharges must not be allowed to restrict or impede the movement of aquatic species indigenous to the waters, impede the passage of normal or expected high flows, or cause the relocation of the waters (unless the primary purpose of the fill is to impound waters).

4. If the discharge creates an impoundment, adverse impacts on the aquatic system caused by the accelerated passage of water or the restriction of its flow must be minimized.

5. Discharges in wetland areas must be avoided.

6. Heavy equipment working in wetlands must be placed on mats.

7. Discharges into breeding and nesting areas for migratory waterfowl must be avoided.

8. All temporary fills must be removed in their entirety.

9. There cannot be any change in preconstruction bottom contours. (Excess material must be removed to an upland disposal area.)

10. The discharge must not occur in the proximity of a public water supply intake.

11. The discharge must not occur in areas of concentrated shellfish production.

12. The discharge must not destroy a threatened or endangered species as identified under the Endangered Species Act or endanger the critical habitat of such species.

13. The discharge must not disrupt the movement of those species of aquatic life indigenous to the waterbody.

14. The discharge must not contain toxic pollutants in other than trace quantities.

15. The fill created by a discharge must be properly maintained to prevent erosion and other nonpoint sources of pollution.

16. The discharge must not occur in a component of the national wild and scenic river system or in a component of a state wild and scenic river system.

17. No access roads, fills, dikes, or other structures can be constructed below the ordinary high water level of the streams under the nationwide permit. These structures would require separate (Section 404) permits.

STATE OF UTAH REQUIREMENTS

1 Each applicant is required by the Utah Code Annotated Section 63-51-10 (Supp. 1981) to submit a financial impact statement and plan to alleviate socioeconomic impacts. Approval of each applicant's plan would be required before issuance of any state permits required to start construction.

2. The Utah Division of Oil, Gas, and Mining (UDOGM), within the Department of Natural Resources and Energy, has responsibility for issuance of permits or approval letters for intention to commence operations. This permit is to ensure protection of the environment prior, during, and following operations.

3. The Utah Division of State Lands and Forestry (UDSLF), within the Department of Natural Resources and Energy, has responsibility for issuance of Right-of-Way/Right-of-Entry permits, under the authority of Utah Code Annotated, 1953, Title 65. The purpose of this permit is to protect the environment and prevent illegal entry on state lands.

4. The Utah Division of Environmental Health (UDEH), Bureau of Air Quality, has responsibility for approval of air pollution sources, under the authority of the Utah Air Conservation Act. The purpose of this permit is to prevent air pollution by any air pollution source except comfort heating.

5. The UDEH, Bureau of Hazardous Wastes and Radiation, has responsibility for approval of plans for hazardous waste management, treatment, storage, or disposal facilities, under the authority of the Utah Solid and Hazardous Waste Act. The purpose of the permit is to prevent faulty construction of these facilities which may constitute hazardous conditions.

6. Water withdrawals, use or acquisition must be in accordance with the state of Utah's appropriation system.

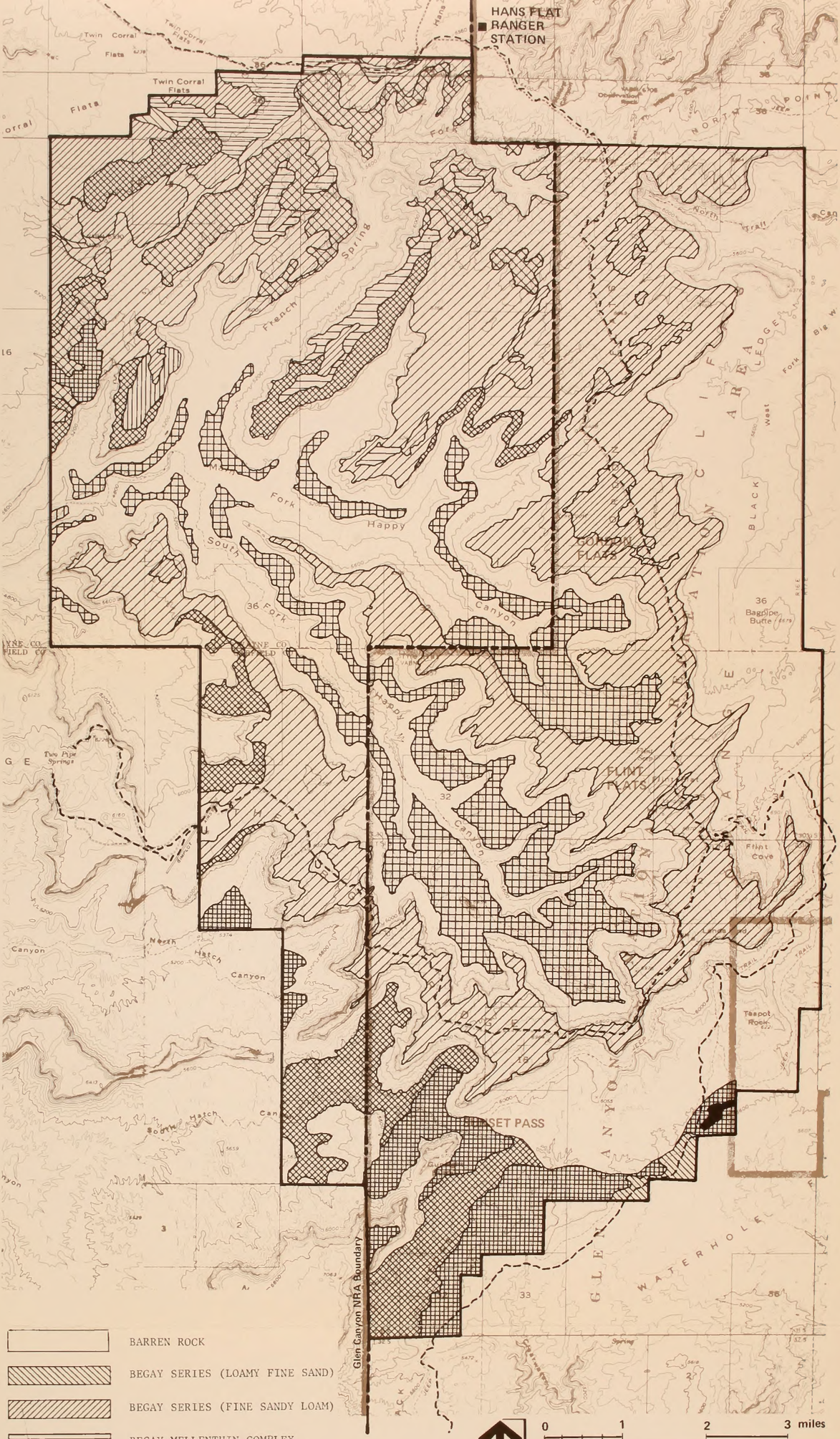
APPENDIX D: SOIL PROFILES

Table 57: Soil Profile Description

Horizon	Depth	Properties
BEGAY SOILS:		These soils are typically found on the mesa tops. Representative geographic areas include Flint and Gordon flats.
A11	0-3 inches	Reddish brown (5YR 5/4) sandy loam; reddish brown (5YR 4/4) moist; weak, very fine subangular blocky structure loose, soft, nonsticky and nonplastic; many very fine, fine, and few coarse roots; few very fine discontinuous pores; strongly alkaline (pH 8.71); clear, wavy boundary
A12	3-12 inches	Yellowish red (5YR 5/6) sandy loam; yellowish red (5YR 4/6) moist; weak, fine, and medium subangular blocky structure; slightly hard, friable, slightly sticky, and nonplastic; common fine, medium, and coarse roots; few very fine discontinuous pores; strongly alkaline (pH 8.99); clear, wavy boundary
AC	12-30 inches	Yellowish red (5YR 5/6) sandy loam; yellowish red (5YR 4/6) moist; massive, slightly hard, firm, slightly sticky, and nonplastic; few medium and coarse roots; few very fine discontinuous pores; strongly alkaline (pH 8.89); gradual, diffuse boundary
C	30-60 inches	Yellowish red (5YR 5/6) sandy loam; yellowish red (5YR 4/6) moist; massive, hard, firm, slightly sticky, and nonplastic; few medium and coarse roots; few very fine discontinuous pores; very strongly alkaline (pH 9.21); gradual; diffuse boundary
MELLENTHIN SOILS:		These soils are also typically found on the mesa tops, but are much shallower. Representative areas include the mesa tops with pinyon-juniper cover and little understory vegetation.
C	0-21 inches	Yellowish red (5YR 5/6) sandy loam; yellowish red (5YR 4/6) moist; single grain, loose, soft, nonsticky, and nonplastic; many fine and medium and few coarse roots; very strongly alkaline (pH 9.07); diffuse, wavy boundary
TALUS SLOPE SOILS:		These soils are typically found at the foot of the cliffs and on the slopes in canyons. Representative areas include the canyon slopes and benches.
A	0-4 inches	Yellowish red (5YR 5/6) extremely gravelly clay loam; yellowish red (5YR 4/6) moist; weak, very fine, and fine platy structure parting to weak, fine, angular blocky; slightly hard, firm, nonsticky, and nonplastic; 85 percent gravel, and cobbles to 4.50 inches in diameter; common very fine and fine roots; few very fine interstitial pores; strongly alkaline (pH 8.77); gradual, diffuse boundary
B	4-8 inches	Dark brown (5YR 4/4) extremely gravelly clay loam; dark brown (5YR 3/4) moist; weak, very fine, and fine platy structure parting to weak, fine, angular blocky; slightly hard, firm nonsticky, and nonplastic; 75 percent gravels, and cobbles to 5.0 inches in diameter; common very fine, fine, medium, coarse, and few very coarse roots; few very fine interstitial and discontinuous pores; strongly alkaline (pH 8.86); gradual, wavy boundary

Horizon	Depth	Properties
C1	8-10 inches	Slightly fractured, weathered sandstone
C2	10-13 inches	Highly fractured, weathered sandstone; more massive and impermeable than the layer above
C3	14 inches	Sandstone, only slightly fractured
RIZNO SOILS:	These soils are typically found on the valley bottoms and are the least uniform of the soil units.	
A	0-6 inches	Light brown (7.5YR 6/4) sandy clay loam; brown (7.5YR 5/4) moist; weak very fine and fine granular structure parting to weak, fine, subangular blocky; slightly hard, friable, nonsticky, and nonplastic; 5 percent subrounded gravels to 0.5 inch in diameter; few very fine, fine, medium, and coarse roots; common very fine and fine discontinuous pores; strongly alkaline (pH 8.91); gradual, wavy boundary
B	6-16 inches	Light brown (7.5YR 6/4) loam; brown (7.5YR 5/4) moist; massive, slightly hard, firm, nonsticky, and nonplastic; 7 percent angular and subangular gravels to 0.5 inch in diameter; few fine, medium, and very coarse roots; common very fine and fine discontinuous pores; strongly alkaline (pH 8.86); clear, wavy boundary
C	16-24 inches	Pinkish gray (7.5YR 7/2) sandy loam; pinkish gray (7.5YR 6/2) moist; massive, hard, firm, slightly sticky, and slightly plastic; 10 percent subangular gravels to 0.75 inches in diameter; few very coarse roots; few very fine, fine, and coarse and discontinuous pores; very strongly alkaline (pH 9.07); gradual, diffuse boundary
R	24 inches	Bedrock
TRAVESSILLA SOILS:	These soils are typically shallow, well drained, moderately permeable soils on mesas, benches, and hillsides.	
A1	0-6 inches	Light yellowish brown (10YR 6/4) fine sandy loam; yellowish brown (10YR 5/4) moist; moderate fine granular structure; soft, very friable, slightly sticky; few fine roots; many very fine and few fine pores; moderately calcareous; carbonates are disseminated; moderately alkaline (pH 8.4); clear smooth boundary
C	6-12 inches	Pale brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine and medium roots; common fine pores; 5 percent pebbles; moderately calcareous; carbonates are disseminated; moderately alkaline (pH 8.3); abrupt smooth boundary
R	12 inches	Sandstone bedrock

Source: Santa Fe Energy Company et al. (1982); for Travessilla soils, USDA, SCS (1983).



BARREN ROCK

BEGAY SERIES (LOAMY FINE SAND)

BEGAY SERIES (FINE SANDY LOAM)

BEGAY-MELLENTHIN COMPLEX

BEGAY-MIDO COMPLEX (LOAMY FINE SAND)

RIZNO SERIES (CHANNERY FINE SANDY LOAM)

RIZNO SERIES-WARM ASPECTS (FINE SANDY LOAM)

FARB SERIES (FINE SANDY LOAM)

MELLENTHIN SERIES (GRAVELLY FINE SANDY LOAM)

MIDO SERIES (LOAMY FINE SAND)

OTERO SERIES (FINE SANDY LOAM)

ARCHES COMPLEX (LOAMY FINE SAND AND ROCK OUTCROP)

TRAVESSILLA COMPLEX (CHANNERY SANDY LOAM AND ROCK OUTCROP)

BADLAND COMPLEX (CHIPETA SILTY CLAY; MOENKOPI FINE SANDY LOAM;
AND NESKAHI FAMILY FINE SANDY LOAM)

APPENDIX E: VEGETATION COMMUNITIES AND SPECIES COMPOSITION

Table 58: Species Composition of Pinyon-Juniper Sagebrush Vegetation Type

	Height (dm)	Percent Cover	Percent Frequency	Density (indiv/ 100 m²)
TREES				
Juniperus osteosperma	to 80	10	34	10
Pinus edulis	to 80	17	42	14
SHRUBS				
Artemisia nova	2-4	1	18	8
Artemisia tridentata	3-15	3	32	11
Crysothamnus greenei		less than 1	6	2
Cowania mexicana		1	2	1
* Echinocereus triglochidiatus				
Ephedra viridis		less than 1	14	6
Eriogonum microthecum		less than 1	4	1
Opuntia spp.		less than 1	14	4
* Sclerocactus parviflorus				
Shepherdia rotundifolia		2	10	4
* Symphoricarpos longiflorus				
Xanthocephalum spp.		less than 1	12	4
Yucca angustissima		less than 1	4	2
PERENNIAL FORBS				
Arabis pulchra		less than 1	6	3
Astragalus ceramicus		less than 1	4	4
Cryptantha flavoculata		less than 1	12	4
* Erigeron pumilus				
Erysimum asperum		less than 1	8	3
* Gilia aggregata				
Lepidium montanum		less than 1	26	15
Pedicularis centranthera		less than 1	4	3
Penstemon cyanocaulis		1	46	41
* Physaria acutifolia				
Senecio multilobatus		less than 1	18	6
* Streptanthus cordatus				
PERENNIAL GRASSES				
Sitanion hystrix		less than 1	6	2
ANNUAL HERBS				
Cryptantha spp.		less than 1	12	
Gilia inconspicua		less than 1	56	
* Streptanthella longirostris				
Vulpia octoflora		less than 1	2	
CRYPTOGAMIC SOIL CRUST		5		

Source: Santa Fe Energy Company et al. (1982).

Table 59: Species Composition of Blackbrush Shrubland Vegetation Type

	Height (dm)	Percent Cover	Percent Frequency	Density (indiv/ 100 m²)
TREES				
Juniperus osteosperma	2-30	2	10	3
Pinus edulis	20-40	1	2	1
SHRUBS				
Artemisia bigelovii		less than 1	4	2
Atriplex canascens		less than 1	12	4
Chrysothamnus greenei		less than 1	4	2
Chrysothamnus nauseousus	10	less than 1	6	2
Coleogyne ramosissima	2-8	9	86	79
Ephedra viridis	5-15	1	10	8
Opuntia spp.		1	34	16
Sclerocactus parviflorus		less than 1	4	1
Xanthocephalum spp.		less than 1	16	6
Yucca angustissima		less than 1	4	5
PERENNIAL FORBS				
Astragalus desperatus		less than 1	2	2
* Cryptantha confertifolia				
Cryptantha flavoculata		less than 1	2	1
Delphinium scaposum		less than 1	14	7
Eurphorbia fendleri		less than 1	4	2
* Hymenoxys richardsonii				
Lepidium montanum		less than 1	8	3
* Sphaeralcea spp.				
PERENNIAL GRASSES				
* Aristida purpurea				
Hilaria jamesii		less than 1	24	53
Oryzopsis hymenoides		less than 1	6	2
Sitanion hystrix		less than 1	2	1
ANNUAL HERBS				
Bromus tectorum		less than 1	86	
Chaenactic stevioides		less than 1	28	
Cryptantha spp.		less than 1	14	
Descurainia pinnata		less than 1	4	
Gilia inconspicua		less than 1	70	
Phacelia corrugata		less than 1	2	
Plantago patagonica		less than 1	12	
Streptanthella longirostris		less than 1	8	
Vulpia octoflora		less than 1	62	
CRYPTOGAMIC SOIL CRUST		11		

Source: Santa Fe Energy Company et al. (1982).

Table 60: Species Composition of Saltbush Vegetation Subtype

	Height (dm)	Percent Cover	Percent Frequency	Density (indiv/ 100 m²)
TREES				
Juniperus osteosperma	15	2	12	3
Pinus edulis	20	2	4	1
SHRUBS				
Atriplex canascens	2	1	36	16
Atriplex confertifolia	2	1	40	12
Brickellia oblongifolia		less than 1	8	2
Chrysothamnus greenei		less than 1	28	9
Chrysothamnus nauseosus		less than 1	4	1
* Coleogyne ramosissima				
Ephedra viridis		less than 1	4	1
Eriogonum corymbosum		less than 1	4	1
Kochia americana		less than 1	16	19
* Sclerocactus parviflorus				
Shepherdia rotundifolia		less than 1	4	1
Xylorhiza glabriuscula		less than 1	16	7
Yucca angustissima		less than 1	8	9
PERENNIAL FORBS				
Arabis pulchra		less than 1	16	6
* Asclepias cryptoceras				
Astragalus moencoppensis		1	32	38
* Calcochortus aereus				
Castilleja chromosa		less than 1	8	2
* Hymenoxys richardsonii				
* Machaeranthera grindelioides				
* Penstemon utahensis				
* Phlox hoodii				
* Streptanthus cordatus				
PERENNIAL GRASSES				
Elymus salina		less than 1	4	1
Hilaria jamesii		1	32	70
Oryzopsis hymenoides		less than 1	20	11
Poa fendleriana		less than 1	8	2
Poa secunda		less than 1	16	12
Sitanion hystrix		less than 1	32	24
ANNUAL HERBS				
Bromus tectorum		less than 1	48	
CRYPTOGAMIC SOIL CRUST		less than 1		

Source: Santa Fe Energy Company et al. (1982).

Table 61: Species Composition of Big Sagebrush Vegetation Type

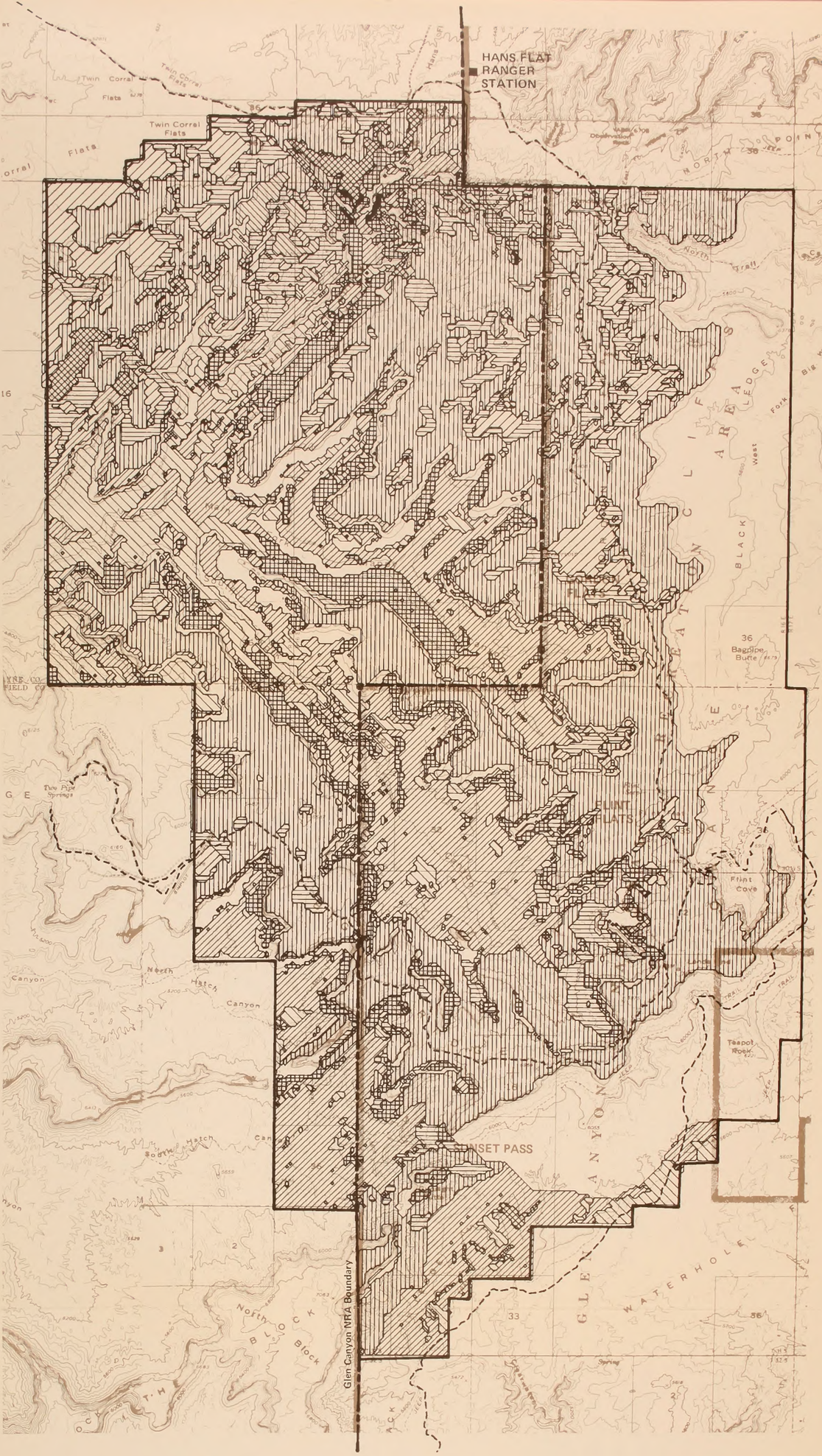
	Height (dm)	Percent Cover	Percent Frequency	Density (indiv/ 100 m²)
SHRUBS				
Artemisia tridentata	5-15	13	80	50
* Atriplex canascens				
Ceretoides lanata		less than 1	36	22
Crysothamnus viscidiflorus		1	20	6
* Echinocereus triglochidiatus				
* Mahonia fremontii				
Opuntia spp.		less than 1	16	6
* Scelrocactus parviflorus				
Zanthocephalum spp.		less than 1	8	2
PERENNIAL FORBS				
* Calochortus nuttallii				
Lepdium montanum		less than 1	4	1
* Penstemon comarrhenus				
Penstemon cyanocaulis		less than 1	16	14
Senecio multilobatus		less than 1	8	2
Sphaeralcea spp.		less than 1	24	60
* Townsendia incana				
PERENNIAL GRASSES				
Bouteloua gracilis		1	16	130
* Oryzopsis hymenoides				
Sitanion hystrix		less than 1	16	4
Stipa comata		less than 1	4	4
Other grasses		less than 1	48	22
ANNUAL HERBS				
Bromus tectorum		2	100	
* Cordylanthus spp.				
Cryptantha spp.		less than 1	48	
Gilia inconspicua		less than 1	24	
Plantago patagonica		less than 1	40	
Sisymbrium spp.		less than 1	28	
Vulpia octoflora		less than 1	16	
CRYPTOGAMIC SOIL CRUST		less than 1		

Source: Santa Fe Energy Company et al. (1982).

Table 62: Species of Slope Vegetation Type

	Height (dm)	Percent Cover	Percent Frequency	Density (indiv/ 100 m²)
TREES				
Juniperus osteosperma	15	2	12	3
Pinus edulis	20	2	4	1
SHRUBS				
Atriplex canescens	2	1	36	16
Atriplex confertifolia	2	1	40	12
Brickellia oblongifolia		1	8	2
Chrysothamnus greenei		1	28	9
Chrysothamnus nauseosus		1	4	1
Ephedra viridis		1	4	1
Erioganum corymbosum		1	4	1
Kochia americana		1	16	19
Shepherdia rotundifolia		1	4	1
Xylorhiza glabriuscula		1	16	7
Yucca angustissima		1	8	9
PERENNIAL FORBS				
Arabis pulchra		1	16	6
Astragalus meoncoppensis		1	32	38
Castilleja chromosa		1	8	2
PERENNIAL GRASSES				
Elymus salina		1	4	1
Hilaria jamesii		1	32	70
Oryzopsis hymenoides		1	20	11
Poa fendleriana		1	8	2
Poa secunda		1	16	12
Sitanion hystrix		1	32	24
ANNUAL HERBS				
Bromus tectorum		1	48	
CRYPTOGAMIC SOIL CRUST		1		

Source: Santa Fe Energy Company et al. (1982).



BADLANDS WOODLAND

BARREN ROCK

BLACKBRUSH SHRUBLAND

PINYON-JUNIPER SHRUB/WOODLAND (BLACKBRUSH ZONE)

PINYON-JUNIPER SHRUB/WOODLAND (SAGEBRUSH ZONE)

PINYON-JUNIPER WOODLAND

SAGEBRUSH SHRUBLAND

SLICKROCK WOODLAND

SLOPE VEGETATION CLASS

CANYON RIPARIAN

Fig. 55. Vegetation

TST	40029
DSC	NOV 83

APPENDIX F: WILDLIFE SPECIES EXPECTED TO OCCUR IN THE PROPOSED FEDERAL LEASE UNIT

Table 63: Checklist of Wildlife Species

Status	Scientific Name	Common Name	Habitat Type: Cliffs & Rocky Slopes	Desert Shrub	Grass-land	P-J Wood-land
	BIRDS					
	Hawks, Eagles, & Owls					
	Cathartes aura	turkey vulture		L	L	
	Accipiter striatus	sharp-shinned hawk			L	
**	Accipiter couperii	Cooper's hawk			L	
	Buteo swainsoni	Swainson's hawk		L	L	
	Buteo jamaicensis	red-tailed hawk			F	
**	Buteo regalis	ferruginous hawk		L	L	
	Buteo lineatus	red-shouldered hawk				L
	Circus cyaneus	marsh hawk				L
**	Buteo lagopus	rough-legged hawk			L	
**	Falco mexicanus	Prairie falcon	L		L	
****	Flaco peregrinus	Peregrine falcon	L			L
**	Flaco sparverius	American kestrel			F	
****	Falco columbarius	Merlin	L		L	L
****	Haliaeetus leucocephalus	bald eagle	L			
**	Aquila chrysaetos	golden eagle	L		L	
	Otus flammeolus	flammulated owl				L
	Bubo virginianus	great horned owl	L			
**	Glaucidium gnoma	pygmy owl				L
***	Speotyto cunicularia	burrowing owl		L		
***	Strix occidentalis	spotted owl				L
	Asio flammeus	short-eared owl		L		
	Game Birds					
*	Alectoris graeca	chukar		L	L	
*	Lophortyx gambelii	Gambel's quail			L	
**	Columba fasciata	band-tailed pigeon				L
	Zenaidura macroura	mourning dove	F		F	F
	Jays, Magpies, & Crows					
	Cyanocitta stelleri	Steller's jay				L
	Aphelocoma coerulescens	scrub jay		L		L
	Corvus corax	common raven	F	F	F	F
	Corvus brachyrhynchos	common crow	L	L	L	L
	Gymnorhinus cyanocephalus	pinyon jay		F	F	F

Status	Scientific Name	Common Name	Habitat Type: Cliffs & Rocky Slopes	Desert Shrub	Grass-land	P-J Wood-land
		Grosbeaks, Finches, Sparrows, and Buntings				
	Pheucticus melanocephalus	black-headed grosbeak		L		L
	Guiraca caerulea	blue grosbeak		L		
	Passerina amoena	lazuli bunting	L	L	L	L
	Carpodacus mexicanus	house finch	F	F		F
	Leucosticte atrata	black rosy finch		L	L	
	Spinus pinus	pine siskin				L
	Spinus tristis	American goldfinch		L		
	Spinus psaltria	lesser goldfinch				L
	Loxia curvirostra	red crossbill				L
	Chlorura chlorura	green-tailed towhee	L	L		
	Pipilo erythrophtalmus	rufous-sided towhee				L
	Calmospiza melanocorys	lark bunting	L		L	
	Passerculus sandwichensis	savannah sparrow		L	L	L
	Pooecetes gramineus	vesper sparrow		L	L	L
	Chondestes grammacus	lark sparrow	F	F		L
	Amphispiza bilineata	black-throated sparrow		L	L	
	Amphispiza belli	sage sparrow		L	L	
	Junco caniceps	gray-headed junco				F
	Spizella arborea	tree sparrow			L	
	Spizella passerina	chipping sparrow		F		F
	Spizella breweri	Brewer's sparrow		F	F	F
	Zonotrichia leucophrys	white-crowned sparrow		L	L	
	Rhynchophanes mccownii	McCown's long spur			L	
		Miscellaneous Bird Species				
	Parus atricapillus	black-capped chickadee				L
	Parus gambeli	mountain chickadee				L
	Parus inornatus	plain titmouse		F		F
	Psaltriparus minimus	bushtit				F
	Sitta carolinensis	white-breasted nuthatch				L
	Sitta canadensis	red-breasted nuthatch				L
	Certhia familiaris	brown creeper				L
	Troglodytes aedon	house wren				L
	Thryomanes bewickii	Bresicks wren		L		L
	Telmatodytes palustris	long-billed marsh wren	F			
	Catherpes mexicanus	canyon wren	F			
	Salpinctes obsoletus	rock wren	F	F		F
	Mimus polyglottos	mockingbird		L	L	L
	Dumetella carolinensis	grey catbird		L		
	Oreoscoptes montanus	sage thrasher		L	L	
	Turdus migratorius	American robin		F		F
	Hylocichla guttata	hermit thrush				L
**	Sialia mexicana	western bluebird		L		L

Status	Scientific Name	Common Name	Habitat Type: Cliffs & Rocky Slopes	Desert Shrub	Grass-land	P-J Wood-land
	Sialia currucoides	mountain bluebird		F		F
	Myadestes townsendi	Townsend's solitaire	L			
	Polioptila caerulea	blue-gray gnatcatcher	L	L		L
	Regulus satrapa	golden-crowned kinglet				L
	Regulus calendula	ruby-crowned kinglet				L
	Bombycilla garrulus	Bohemian wax wing				L
	Lanius ludovicianus	loggerhead shrike				L
	Lanius excubitor	northern shrike		L		
	Sturnus vulgaris	starling	L	L	L	L
	Dendroica auduboni	Audubon's warbler				L
	Dencroica nigrescens	black-throated gray warbler				F
**	Dendroica graciae	Grace's warbler				L
	Vireo vicinior	gray vireo				F
	Sturnella neglecta	western meadowlark		L	L	
**	Icterus parisorum	Scott's oriole		L		F
	Euphagus cyanocephalus	Brewer's blackbird		L		
	Molothrus ater	brown-headed cowbird		F		F
	Tyrannus vociferans	Cassin's kingbird		F		
	Tyrannus tyrannus	eastern kingbird			L	
	Myiarchus cinerascens	ash-throated flycatcher	F	L		L
	Sayornis nigricans	black phoebe		L		
	Sayornis saya	Say's phoebe		F		F
	Empidonax traillii	Traill's flycatcher		L		
	Empidonax difficilis	western flycatcher			L	
	Contopus sordidulus	western wood pewee				L
	Nuttallornis borealis	olive-sided flycatcher				L
	Eremophila alpestris	horned lark		F	F	
	Tachycineta thalassina	violet-green swallow	F	F	F	F
	Petrochelidon pyrrhonota	cliff swallow	L			
	Colaptes cafer	common flicker	L		L	
	Dendrocopos villosus	hairy woodpecker				L
***	Dendrocopos pubescens	downy woodpecker				L
	Coccyzus americanus	roadrunner		L		
	Geococcyx californianus	yellow-billed cuckoo		L		
	Phalaenoptilus nuttallii	poor-will		L		
	Chordeiles minor	common nighthawk		L		L
	Aeronautes saxatalis	white-throated swift		F		F
	Archilochus alexandri	black-chinned hummingbird		L		
	Selasphorus platycercus	broad-tailed hummingbird		L		L

Status	Scientific Name	Common Name	Habitat Type: Cliffs & Rocky Slopes	Desert Shrub	Grass-land	P-J Wood-land
	MAMMALS					
	Insectivores					
	Sorex merriami	Merriams shrew		L	L	L
	Sorex obscurus	dusky shrew				L
	Sorex palustris	water shrew				L
	Sorex nanus	dwarf shrew				L
	Sorex cinereus	masked shrew				L
	Bats					
	Myotis lucifugus	little brown myotis	L			L
	Myotis yumanensis	Yuma myotis		L		
	Myotis evotis	long-eared myotis	L			
	Myotis volans	hairy-winged myotis	L	L	L	L
	Myotis californicus	California myotis	L	L	L	L
	Myotis subulatus	small-footed myotis	L	L	L	L
	Lasionycteris noctivagans	silvery-haired myotis	L	L	L	L
	Pipistrellus hesperus	Western pipistrelle	L	L	L	L
	Eptesicus fuscus	big brown bat	L	L	L	L
	Lasiurus cinereus	hoary bat	L	L	L	L
	Plecotus townsendii	Western big-eared bat	L	L	L	L
	Antrozous pallidus	Pallid bat	L	L	L	L
	Tadarida mexicana	Mexican free-tailed bat	L	L	L	L
	Hares, Rabbits, and Pikas					
	Ochotona princeps	Pika	L		L	
	Lepus townsendii	white-tailed jackrabbit				L
	Lepus californicus	black-tailed jackrabbit	F	F	F	F
	Sylvilagus nuttallii	Nuttall cottontail	L			L
	Sylvilagus audobonii	Audubon cottontail		L		
	Rodents					
	Sciurus aberti	Abert squirrel				
	Tamiasciurus hudsonicus	red squirrel				L
	Marmota flaviventris	yellow-bellied marmot				F
	Cynomys leucurus	white-tailed prairie dog				
	Citellus spilosoma	spotted ground squirrel	L	L	L	L
	Citellus variegatus	rock squirrel	F	F		
	Citellus lateralis	golden mantled squirrel				L
	Ammospermophilus leucurus	antelope ground squirrel		L		

Status	Scientific Name	Common Name	Habitat Type: Cliffs & Rocky Slopes	Desert Shrub	Grass-land	P-J Wood-land
	Eutamias minimus	least chipmunk				L
	Eutamias umbrinus	Uinta chipmunk				L
	Eutamias quadrivittatus	Colorado chipmunk		L		
	Eutamias dorsalis	cliff chipmunk		L		
	Thomamys talipoides	northern pocket gopher				L
	Thomomys bottae	Botta picket gopher	L	L		L
	Perognathus apache	Apache pocketmouse		L		
	Perognathus longimembris	little pocketmouse		L		
	Perognathus parvus	Great Basin pocketmouse	L	L		L
	Perognathus formosus	long-tailed pocketmouse		L		
	Peromyscus crinitus	canyon mouse		L		
	Peromyscus maniculatus	deer mouse	L	L	L	L
	Peromyscus boylei	brush mouse	F			
	Peromyscus truei	pinyon mouse	L			F
	Peromyscus difficilis	rock mouse	L	L	L	L
	Onychomys leucogaster	northern grasshopper mouse		L		
	Neotoma albigula	white-throated wood rat		L		
	Neotoma mexicana	Mexican wood rat	L			L
	Neotoma lipida	desert wood rat	L	L		
	Neotoma stephensi	Stephens wood rat	L	L		
	Neotoma cinerea	bushy-tailed wood rat	L			L
	Lagurus curtatus	sagebrush vole				L
	Microtus longicaudus	long-tailed meadow mouse				L
	Microtus mexicanus	mexican vole				L
	Phenacomys intermedius	heather vole				L
	Reithrodontomys megalotis	Western harvest mouse	L	L	L	L
*	Zapus princeps	big jumping mouse				L
	Castor canadensis	beaver	L	L	L	L
	Erethizon dorsatum	porcupine	L	L	L	L
*,**	Carnivores					
	Canis latrans	coyote	L	L	L	L
	Vulpes fulva	red fox		L		
	Urocyon cinereoargenteus	gray fox	L	L	L	L
	Ursus americanus	black bear				L
	Bassariscus astutus	ring-tailed cat		L		
	Mustela erminea	ermine				L
	Mustela frenata	long-tailed weasel				L
	Taxidea taxus	badger	L	L	L	L
	Mephitis mephitis	striped skunk	L	L	L	L
*,**	Spilogale gracilis	spotted skunk	L	L		
*	Lynx rufus	bobcat	L	L	L	L
	Felis concolor	mountain lion	L	L	L	L

Status	Scientific Name	Common Name	Habitat Type			
			Cliffs & Rocky Slopes	Desert Shrub	Grass-land	P-J Wood-land
		Ungulates				
*	Odocoileus hemionus	mule deer	F	F	F	F
*	Antilocapra americana	prong-horned antelope		L	L	
*	Cervus canadensis	elk				L
	Bison bison	bison		L	L	
*,**	Ovis canadensis	desert bighorn sheep	L			

Source: USID, BLM (1976 and 1982); USPS (n.d.); Sigler and Associates (1982).

F = recent field studies
L = literature review
* = species of special state interest
** = migratory species of high federal interest
*** = species being considered for inclusion on the federal threatened and endangered species list
**** = species on the federal threatened and endangered species list
+ = sighted within the proposed federal lease unit

APPENDIX G: NOISE

Sound is a form of energy, usually generated when an object vibrates. Noise is unwanted or objectionable sound. The effect of noise level depends upon the characteristics of the sound energy (magnitude, frequency, duration) and of the receptor (auditory and nonauditory characteristics). As receptors vary in sensitivity and in response to sound energy, any quantification of impact is necessarily somewhat subjective. There are two major categories of adverse impact due to noise--auditory (impairment or loss of hearing) and nonauditory (sleep disturbance, elevated stress levels, disrupted physiological functions, and psychological effects such as annoyance and irritability).

The U.S. Environmental Protection Agency has established noise level guidelines for humans for "equivalent sound levels." Equivalent sound levels are calculated using an equation that yields an equivalent point noise source for a site or a project that contains many diffuse sources of noise, as follows:

$$L_{eq} = 10 \log_{10} \sum_{i=1}^{k} N_i F_i 10^{(Lpi/10)}$$

where:

L_{eq} = the equivalent sound level for the site

k = number of categories of equipment types in operation at the site

N_i = number of equipment units within the ith of the k categories of equipment at the site

F_i = equipment use factor for the ith of the k categories of equipment at the site, in percentage of a 24-hour day that the ith category is operated, on average

L_{pi} = maximum A-weighted sound level in decibels (db) from one piece of equipment in the ith category of the k categories, measured at a distance of 3 feet from the sound source

Once the sound is aggregated as a single equivalent source using the above equation, the sound level at receptors at given distances outside the project area are estimated as follows:

$$L_p = (L_{eq}) + (20 \log_{10} r) + 0.5db$$

where:

L_p = sound pressure at the receptor (in db)

L_{eq} = equivalent sound pressure of the site (in db)

r = distance from the source to the receptor (in meters)

This pair of equations shows the physical level of sound pressure at a receptor located a given distance from a site that is generating noise from a number of different equipment sources and types. These equations do not, however, take

into account factors such as sound absorption or deflection by terrain, vegetation, etc. These equations also do not account for sensitivity (auditory or nonauditory) by either human or animal receptors. In addition, no adjustments have been made for impulse-type noise versus continuous noise, nor have the figures been adjusted to account for enhanced nonauditory effects due to sound that is of round-the-clock duration. All calculations are based on a simplifying aggregation technique and on physical attenuation over distance only. As such, the calculations would be expected to yield results that are less than would be measured in the field in some instances and that are exaggerated in others. As a simple screening technique to demonstrate the overall magnitude of noise impacts, however, this calculation is considered to be adequate.

The EPA has identified recommended maximum year-round average noise levels. To ensure protection of public health and safety; the following noise levels should not be exceeded (EPA 1974).

Effect	Noise Level	Type of Area
Hearing loss	L_{eq} = 70 db or less	All areas
Outdoor activity interference	L_{eq} = 55 db or less	Outdoors where people spend widely varying amounts of time, and other places where quiet is a basis for use

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